Investigating the Circular Economy and its Impact in the UK Manufacturing Sector

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ASTON UNIVERSITY

October 2020

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Thesis Abstract

This PhD thesis investigates the circular economy and how it impacts UK manufacturing. The research explores the Automotive, IT firms and Government agencies – how they understand, construct, and operationalise a circular economy for achieving competitive advantage. It also assesses if the RBV's VRIN framework is suitable for a firm participating in the circular economy.

This research employs a critical realist qualitative comparative case study method. Primary data collection included semi-structured interviews with thirty-four interviewees drawn from thirty firms across the UK automotive, IT firms and government agencies. The study used secondary data collected from firms' sustainability reports and waste management policy documents to triangulate interviewees responses.

The key finding is that an augmented waste hierarchy is the most realistic description of a circular economy. There is a convergence between the automotive and IT industries with SMEs driving change. It also revealed theory- practice contradictions, giving rise to two types of a circular economy- a Standard Circular Economy and an Advanced Circular Economy. It draws a list of characteristics for finding each type for helping managers make informed decisions.

The theory-practice contradictions resulted in an Intention-Practise-Outcome Model. It is about synchronising a firm's organisational resources with circular economy strategic intent and practise. In turn, it helps firms deliver economic, environmental, and societal benefits—an avenue for future circular economy research.

This PhD thesis also contributes theoretically to the RBV theory by finding that VRIN characteristics of resources are not yet proven suitable for a circular economy business. Identifying a circular economy as a dynamic capability identifies a new competitive advantage, which provides new directions in strategic management research. This research informs urban

mining, natural capital policymaking, highlighting a need for connecting waste-hierarchy, Industry 4.0, and innovation policy.

This research study contributes to the new developing circular economy scholarship and enhances business sustainability and strategic management knowledge domains.

Executive Summary

Investigating the Circular Economy and its Impact
in the UK Manufacturing Sector

This PhD thesis reports an investigation regarding an understanding of the circular economy. Firstly, it reviews different pieces of academic and non-academic literature on the circular economy. Secondly, it investigates how the UK automotive, IT firms, and Government agencies understand, construct, and operationalise the circular economy for achieving competitive advantage. It also assesses if RBV's (resource-based view) VRIN (valuable, rare, inimitable, non-substitutable) framework is suitable for a firm practising a circular economy.

This research study considers the following four research questions (RQs):

- *RQ1: What best describes the current understanding, construction, and operationalisation of the circular economy by UK manufacturing firms, and government agencies?*
- *RQ2: How do firms manage waste?*
- *RQ3: How does the understanding of the circular economy affect the characteristics of resources required for achieving a competitive advantage within circular economy environments?*
- *RQ4: What are the policy implications of the circular economy influencing the use of resources?*

Due to these research questions' nature, the research method is predominantly qualitative, informed by Critical Realism. This philosophical tradition allows flexibility in choosing methods to recognise the most accurate knowledge of different objects in the world. It allows a more in-depth understanding of a circular economy. The research strategy employed was multiple cases comparisons. This strategy facilitates looking closely at events, their causal mechanisms, and structures at different aggregation levels, linking the understanding to achieving competitive advantage by firms.

There were three distinct phases in this research study (see Appendix 1). They are: (a) a familiarisation phase; (b) finding empirical traces of the circular economy in the historical roots of sustainable development and its central tenet for identifying its theoretical base from a strategic management perspective; (c) development of a conceptual framework for this research study, configuring steps for analysis, data collection, application and evaluation.

In the first phase, the author took part in several circular economy workshops, seminars, industry events, All-Party Parliament Groups, and policy discussions in the British Parliament to familiarise himself with the circular economy, which subsequently informed this study. These participations helped the author learn that the circular economy is a new phenomenon that is still unfolding and helped identify that ‘resources’ and ‘managerial capabilities’ are central to the circular economy from a strategic management perspective. As a result, the resource-based theory, and its extension of the dynamic capabilities theory, were selected to provide a theoretical basis for the circular economy. Following this, a conceptual framework for this research study was developed, laying down the seven steps for organising interview data to answer the research questions.

Data collection to understand the circular economy and how it is implemented was through semi-structured personal interviews. The participants sharing their lived experiences were from senior management teams or were entrepreneurs. The participating team members were of the ranks of managing directors, directors, heads of departments, and functional heads responsible for the design, delivery, and implementation/ evaluation of environmentally friendly solutions, including championing the firm's circular economy initiatives. Interviews varied in length, but they usually took between one and two hours.

In the inner nest case 1, the automotive group of firms has five economic segments, together with eleven firms, whereas the inner nest, case 2 has a group of IT firms with six economic segments and eight firms. In the outer case, nest case 3 has eleven governmental agencies. In total, there are three cases with thirty firms and government agencies with thirty-four participants across the three cases.

The reasons for choosing automotive and IT firms from UK manufacturing were: (a) the automotive is the oldest, technically advanced British heritage manufacturing sector. It is directly dependent upon mined raw material resources and is susceptible to any fluctuations in its prices. Also, it is strategic to the UK economy and a key provider of jobs and wealth creation (b) the IT firms form the second-largest manufacturing sector in the UK and considered to be the backbone for many manufacturing industries. The Government agencies are responsible for policymaking and maintaining the depleting natural resource reserves, including protecting and safeguarding the UK's environment and natural resources.

Furthermore, automotive firms are highly dependent on fossil fuels. With the ever-increasing pressure to reduce CO_2 emissions globally, car manufacturers are hugely impacted both in terms of their production processes and their vehicle emissions (tailpipe emissions). As a result, they are always on the lookout to reduce their vehicle weight and their dependence on virgin raw material resources. Additionally, their low margins and high capital investment make it more urgent for them to look for hedging risks.

Similarly, IT firms are dependent on critical rare earth elements. These are scarce, while the demand for electronic products and services are on an upward swing. The IT firms are also heavily dependent upon the derivatives of hydrocarbons for manufacturing its components, and their prices are also highly fluctuating, along with the prices of crude petroleum. Therefore, IT firms are also on the lookout for hedging their raw materials resource supply risks.

This research considers the firm's understanding of the circular economy as the unit of analysis informed by participants for data analysis consistency. It allowed looking at different understandings, vis-à-vis specific operational activities in different contexts and investigates how understanding a circular economy translates into practice. Also, it explores how it impacts a firm's consumption of raw material resources.

This thesis's findings show that an augmented waste hierarchy is the most realistic description of a circular economy. Closed-loop recycling is the next closest concept that describes a circular economy. Most of the Case companies engage in practising the 4Rs of a waste hierarchy, i.e. reduce, reuse, recycle and recover. Amongst these, companies predominantly practise recycling in a variety of different ways. Usually, the 4R processes are augmented by technology, thereby elaborating and transforming the structure and mechanisms of a waste hierarchy.

The study also reveals many dichotomies and paradoxes in a circular economy's practice as an augmented waste hierarchy. For example, it is easier and cheaper for Case companies to use virgin raw material resources than to use recyclate materials. There is a strong power play between the OEMs (Original Equipment Manufacturers) and recyclers and remanufacturers in the automotive sector, and the same kind of power play is found between IT OEMs and their high-value clients. The recyclers and remanufacturers in both sectors face the challenge of securing a steady supply of used components/ end-of-life products. Most of them are SMEs (Small and Medium Enterprises).

The entrepreneurial firms face a challenge from large OEMs, despite coming up with innovative products and solutions. The large OEMs block the small entrepreneurial companies from implementing new products and services through new business models.

The governmental agencies showed a lack of agreed understanding of the circular economy. There was a lack of coordination between different governmental agencies for implementing the circular economy. For example, the nodal agency responsible for developing the 25-year environmental plan understands the circular economy differently from its delivery partners. Similarly, the delivery agencies do not seem to coordinate with local agencies responsible for implementing the policies. Likewise, frequently changing waste legislations deprive the metal and non-metal recyclers of getting a return on their investments. Hence, they cut corners. However, the devolved Governments such as the Welsh Government are implementing a circular economy more effectively than their counterparts. They have recognised the need to make a circular economy mainstream, so they have moved it from the Natural Resources department to their Economy department.

Such paradoxes and dichotomies led this research study to distinguish between two types of prevalent practices of the circular economy, viz., (a) a Standard Circular Economy and (b) an Advanced Circular Economy. Furthermore, the study developed an Intention-Practice-Outcome model for synchronising a firm’s intention with its practice and delivering much needed economic, environmental, and societal benefits. This model is in its infancy, offering an avenue for future circular economy research.

This research study contributes to the theory and practice of a circular economy. Theoretically, it identifies the resource-based view, dynamic capabilities framework, capabilities view of a firm as the theoretical base for developing the circular economy as a meta-theory of competitive advantage. Further, it finds that the VRIN characteristics of resources are not yet proven suitable for a circular economy business. Identifying a circular economy as a dynamic capability identifies the emergence of a new competitive advantage. This new competitive advantage takes into consideration not only the economic perspective but also the environmental and societal dimensions. It thereby allows a firm’s senior management team to make informed decisions.

For practice, the contribution starts from the identification of a circular economy as an augmented waste hierarchy. It makes a circular economy easy to understand for a specialist as well as a non-specialist manager. Further, the identification of two types of the circular economy, and providing a list of characteristics for finding each type, helps firm managers and senior managers to choose their firm’s processes (ways of coordinating, combining and recombining resources), positions (firm’s specific resources position), and paths (achieving economic benefits alone or all the three dimensions together) for achieving a conventional or new competitive advantage.

This research informs urban mining policy and natural capital policy. As the circular economy grows, there would be more demand for used or end-of-life products and components. Firms have started focusing on urban waste yards, and this is a highly disorganised sector. A clear-cut policy dealing with urban mining, including waste data, would help keep the country's waste for further harvesting. The UK and European countries produce only one critical rare earth element, Hafnium, out of the twenty-seven critical raw materials identified by the European Commission. Creating a non-discriminatory supplementary Natural Capital policy would help both large corporations and SMEs access the strategic resources market. Equally important is a policy linking the circular economy, Industry 4.0, and innovation to reap the benefits across three dimensions- the economic, environmental, and societal.

Keywords: *circular economy, waste hierarchy, business sustainability, sustainability, resource-based view, VRIN framework, dynamic capabilities, competitive advantage, policymaking.*

I dedicate this thesis to the loving memory of my parents,

Mrs and Mr Nizamuddin Gabbur

Conference Papers:

1. Gabbur, A; Nunes, B (2017). RBV in the context of the circular economy. Accepted for presentation at the British Academy of Management Annual Conference, University of Warwick. Date: From 5th to the 7th of September 2017.

2. Gabbur, A. (2017) Sustainability or The circular economy: Which one will you choose? Proceedings of the CE2S Conference, The circular economy: Transitioning to Sustainability organised by Coventry University (CBiS), The Sheffield University Management School (CReiMS) and Academy of Marketing Sustainability SIG, at Coventry University, 11th July 2017.

3. Gabbur, A., Spicer, D., Taylor, A. (2014). Exploring dynamic capabilities in the context of the circular economy. Proceedings of the British Academy of Management Annual Conference - ISBN: 978-0-9549608-7-2, Ulster Business School, Ulster University, Belfast 9th -11th September 2014.

Acknowledgements

All praises are due to my Creator, the most gracious, the most merciful.

I thank profusely to all those who have helped me in this journey, although it is difficult to mention all the names here, but I remember and thank them each day for the difference they have made in my life.

A special mention is needed for Prof David Bailey and Dr Breno Nunes for their support, guidance, intellectual rigour, friendship, and patience. Most importantly, for putting their trust, and giving me a free hand in developing the ideas that I hope the readers would find intellectually stimulating.

I am grateful to Prof Nicholas O'Regan for supporting me while I was going through adversities, encouraging, and instilling in me the positivity required to deal with those challenging circumstances. Feedbacks and peer-reviews are a vital part of any academic work - I sincerely thank Dr Helen Borland for providing me with her critical reviews, thereby helping me to improve my thesis immensely.

For me, Mr Faiz Parkar of IT department is a Guardian Angel! It is because of his selfless on-demand technical support that, I was able to continue my work, unhindered.

Finally, my most enormous privilege and honour is my wife's camaraderie that saw this research project to fruition.

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List of Abbreviations

APPG	**:**	All-Party Parliamentary Group
BIS	**:**	Department of Business Innovation and Skills
CE	**:**	The Circular Economy
CSD	**:**	Commission on Sustainable Development
c.f.	:	Cross-reference
DC	**:**	Dynamic Capabilities
DECC	**:**	Department of Energy and Climate Change
DEFRA	**:**	Department of Food and Rural Affairs
DFID	**:**	Department of International Development
EA	**:**	Environment Agency
EMF	**:**	The Ellen MacArthur Foundation
EC	**:**	The European Commission
GHG	**:**	Green House Gas Emissions
HSSMI	**:**	The High-Speed Sustainable Manufacturing Institute
IERC	**:**	European Research Cluster on the Internet of Things
LP	**:**	Local Partnerships
LWARB	**:**	The London Waste and Recycling Board
MAKE $_{\text{UK}}$	**:**	The UK Manufacturer's Association
OECD	**:**	Organisation for Economic Co-operation and Development
OEM	**:**	Original Equipment Manufacturer
GHG	**:**	Green House Gas or CO_2 emissions
SCA	**:**	Sustained Competitive Advantage
SMMT	**:**	The Society of Motor Manufacturers & Traders
SMEs	**:**	Small and Medium Enterprises
techUK®	**:**	The Association of Technologies Companies
WCED	**:**	World Commission on Environment and Development
WEF	**:**	World Economic Forum
WRAP	**:**	The Waste Resource Action Programme
WSSD	**:**	World Summit on Sustainable Development
UNSDP	**:**	United Nation Sustainable Development Programme
UN-ESC	**:**	United Nations Economic and Social Council
UNEP	**:**	United Nations Environment Programme
ZWS	**:**	Zero-Waste Scotland

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Part One

Chapter 1 Introduction to the research

1.1 Introduction

This research study investigates the circular economy in UK manufacturing firms and Government agencies using a critical realist lens, i.e., how they understand, construct, and operationalise the circular economy for achieving a competitive advantage.

The reason for this research is to bring clarity to the understanding of the circular economy with a view that it would provide a clear destination to both the private and public sector initiatives for addressing the raw material resources scarcity. Also, it would help to address the global concerns of environmental degradation and climate change. The motivation of this research stems from (a) the popularity of the circular economy and its projected benefits for businesses and regions (the Governments) – the practice perspective, and (b) the need to unpack the overlapping concepts and identify its theoretical base - the theoretical prospect of the circular economy.

a) ***The growing popularity and potentials of the circular economy – the practice perspective***

Globally, crises started to deepen after the 2007-08 economic recession. Today, we are witnessing a World plagued by resource scarcity, ecological destruction, climate change, food and water scarcity, and population growth, to mention, but a few. The European Union is witnessing migration crises, political polarisation, and inequalities. It has resulted in deep territorial divisions, and calls for a sustainable, cohesive and inclusive growth is ever-growing not only in Europe (European Commission, 2009, 2015, 2015a, 2017a, b; 2019, Bachtler et al., 2019) but also globally (McKinsey Global Institute, 2011; UNEP, 2011; UNU-IHDP, 2014; UN-Water, 2015; Chertow and Park, 2016; UNEP, 2017; Brown et al., 2018).

The UK economy also has been showing significant signs of strain for the last several years, and despite the government's austerity drive, the economy is far from recovery. UK productivity growth has not been steady since 2007 (MAKEuk, 2018). With rising political uncertainty due to Brexit, the UK's manufacturing sector faces high supply risks because of its high dependency on imports of raw material resources leading to its soaring prices. It impacts the manufacturer's margins because approximately 40% of the manufacturing cost goes into procuring raw material resources (EEF, 2014). Several trading bodies and trade associations are concerned about the high prices and supply risks, dampening business investments, output, and jobs (SMMT, 2019). Brexit has impacted all sectors.

Specifically, the automotive industry is witnessing large OEMs shutting down plants and shifting their production base out of the UK. (Bailey and De Propris, 2017; Bailey et al., 2019a; Bailey et al., 2019b). The call for an economic model that can integrate economic activity, environmental degradation, and wellbeing sustainably is getting even louder (Fox, 2012).

Different UK top government agencies took major initiatives (e.g., DEFRA, BIS, DECC, Foreign Office, and DFID) to understand the UK's growth prospects concerning its natural-resources position, state of climate change and related initiatives. It got shelved due to the Treasury's cold response – this was revealed in a freedom of information request filed in March 2013. The reason for such non-cooperation is still not known (EEF, 2014). Further, EEF (2014 see Box. 2, p. 10) informs that there is no coordination between the seven government agencies dealing with natural raw material resources, waste, skills and capabilities, energy, and climate change. Also, there is no overarching vision or policy concerning the reserves of natural raw material resources and waste (EEF, 2015).

The circular economy has gained significant popularity since 2014 and is considered a panacea for addressing most crises, such as depleting raw material resources, climate change, ecological deterioration, unemployment, regional disparities, economic recession, migration, and many more.

Ex-ante many reports by both the government as well as private agencies including the third sectors such as the EMF, Top Consulting firms such as McKinsey and Co., NGOs (Non-Governmental Organisations) trade associations and APPGs (All-Party Parliamentary Group), all are of the view that a circular economy could be beneficial for businesses. For example, BIS (Department for Business, Innovation and Skills) suggests that UK businesses could gain £23 billion per year through resource efficiency employing a circular economy. Innovate UK (2015) contends that raw material resources costs could be cut by at least 20% by improving re-use. Lavery et al. (2013 p.10) estimate that the UK manufacturing sector can generate an additional £10 billion per year as an extra profit. Additionally, it can create 314,000 new manufacturing jobs and reduce 20 million tons of GHG (Green House Gas) per annum by just making businesses closed loop. McKinsey Global Institute (2011), contends that globally, the circular economy could potentially save US$2.0 trillion by 2030 in resource productivity alone. The EMF (2012) argues that the circular economy offers a net material cost savings opportunity of up to US$380 billion in a transition scenario, and up to US$630 billion in an advanced situation, considering only a subset of the EU manufacturing sector.

The Ellen MacArthur Foundation is ahead of the curve among different government agencies, private firms and charities promoting the circular economy. The author attended the Ellen

MacArthur Foundation's organised event titled 'Schmidt-Arthur Public Lecture on the Circular Economy' in June 2013 at The Royal Institution of Great Britain, London[1]. Thought leaders such as Dame Ellen MacArthur, Mr Eric Schmidt, Professor Walter Stahel, Professor Michael Braungart, Professor William McDonough, Ms Rachel Botsman and Ms Janine Benyus attended the seminar meeting. They felt that while each is doing his/her best to encourage 'do more with less' efforts, there is a need to define clear business values. A real marketing effort is needed to bring all the different works to the mainstream under one umbrella. Thus, after 2013, intense marketing activities by the Ellen MacArthur Foundation ensued. After this event, many top universities, mainly from the UK, Europe and the USA, the national and local governments, and the FTSE 100 and 500 companies, started campaigning for a circular economy. The aggressive marketing efforts by the Ellen MacArthur Foundation saw the circular economy included in the World Economic Forum's agenda. A year later, the circular economy became a part of the European Commission's plans to address climate change and depleting natural resources. They also expected a circular economy to be added to the UN Sustainable Goals.

The EMF (The Ellen MacArthur Foundation) funded McKinsey and Co. to conduct a study on the Circular Economy, and together they published three reports explaining its benefits (EMF, 2012, 2013b, 2014). A few years later, as part of its marketing campaign to promote the Circular Economy, the Ellen MacArthur started an elite 'Circular Economic 100 Club.' Its members include FTSE 100 and 500 multinational corporations, top Ivy League HE (Higher Education) Universities across the globe, and national as well as regional governments. Some of the FTSE 100 and 500 names of the CE100 Club member corporations are Google™, Sun Microsystems, Cisco, Apple, SAP, DuPont, Caterpillar, Philips Unilever, and IKEA, to name just a few. The top HE Universities include Imperial College, UCL, Bradford University, Cranfield University, TU Delft, University of Queensland, Montreal University, and many more. These universities form the intellectual base of the circular economy as they publish research articles in mainstream journals. Simultaneously, the EMF publishing company is also releasing circular economy content into the market very actively. In short, the EMF has established a community that pushes its circular economy agenda.

As a result of the projected potential benefits of the circular economy many western Governments have signed up for transitioning their economy to a circular economy model. These governments formulate appropriate policy measures to implement the circular economy. As an example, the European Commission (2011; updated in, 2018), having identified the scarcity of raw materials in the European regions (Britain included) has proposed transitioning to a circular economy

[1] See the highlighted portion in Appendix 3.

evident from the opening policy statement in its' communication number 'COM (2015) 614 final', presented below:

> 'The transition to a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised, is an essential contribution to the EU's efforts to develop a sustainable, low carbon, resource-efficient and competitive economy. Such a transition is the opportunity to transform our economy and generate new and sustainable competitive advantages for Europe.' (European Commission, 2015 p. 2).

The European Commission considers that for exercising and actualising the powers possessed by the circular economy a coherent policy framework, and policy dialogues and partnerships in trade and development are required across different industry sectors, expressed in the quote below:

> 'The Commission will examine options and actions for a more coherent policy framework of the different strands of work of its product policy in their contribution to the circular economy.' (European Commission, 2015 p. 4)

Some of the European Commission's policy initiatives include supporting promising developments through its research and innovation financing programme, Horizon2020, and funding Cohesion Policy (European Commission, 2015 p. 5).

The UK Government's policy response to raw material resources scarcity came in the form of 'The Resource Security Action Plan (RSAP) 2012' developed by DEFRA (Department for Environment, Food and Rural Affairs) and BIS (Department of Business Innovation and Skills) (Hill, 2016). It mentioned the benefits of transitioning to a circular economy business models citing the Ellen MacArthur Foundation's circular economy report published in 2012 (EMF, 2012). The UK Government's policy intervention included (a) Innovation Challenge Fund coordinated through Technology Strategy Board., (b)Individual Producers' Responsibility (c) Data capture of waste electrical and electronic equipment, and many more policies to promote the circular economy objectives of reducing the consumption of raw material resources (HM Government, 2012 p. 29).

The UK's 'Industrial Strategy' and DEFRA's twenty-five-year plan to improve the environment also commits to moving towards a regenerative circular economy (HM Government, 2017 p. 148-149, 2018 p. 84).

Despite several potentials for economic benefits and policy interventions from the European Commission and the UK government, UK businesses' uptake of the circular economy has been very slow (Lavery, 2014). The reasons for this slow uptake, despite the circular economy's immense raw material resources saving potentials, raises curiosity and motivates this investigation.

b) The need to unpack the confusion and conflation - the theoretical perspective

The European Commission has referred to the circular economy differently in its other communications. For example, it has referred to the circular economy as a 'zero-waste programme' in its 'COM (2014) 398 final' (European Commission, 2014). Then, as 'closing the loop' in its 'COM (2015) 614 final' (European Commission, 2015), and more recently it has put the circular economy central to implementing its 'new industrial strategy' in its 'COM (2020) 98 final' and COM (2020) 102 final' for building a competitive Europe (European Commission, 2020a; European Commission). Clearly, the European Commission is trying to leverage the circular economy to build a regional competitive advantage.

Similarly, the United Nations Environment Programme included the circular economy as a part of its sustainable growth plans (UNEP, 2006, 2011, 2013, 2017).

The European Commission, Ellen MacArthur Foundation, and United Nations Environment Programme, including the academics, refer to a circular economy differently at separate times (Millar et al., 2019). For example, the EMF refers to the circular economy as a 'regenerative economy.' At other times, it refers to the circular economy as 'an industrial system that is restorative.' The EMF also refers to the circular economy as 'an economic model'; 'a strategy about closing the loop managed through systems thinking, working towards resource efficiency, and eco-efficiency'; underpinned by 'design thinking preventing pollution and virgin materials and restricting the output of wastes.

The UK industrial strategy refers to the circular economy as 'raising productivity by using resources more efficiently' (HM Government, 2017, p.148). UNESC (2018) (United Nations Economic and Social Council) refers to the circular economy as 'the circular economy model'. The WEF (2014) (World Economic Forum) describes the circular economy as a 'business model'. In its action plan, the European Commission (2015) adds 'closing the loop' before mentioning 'the EU action plan for the circular economy'. (UNEP, 2011); UNEP (2017) considers the circular economy as a model and treats the circular economy and green economy as the same. Consequently, there is a critical need within the UK and Europe to understand better the circular economy and how public policies can help it to implement it, including business operations, and organisational strategy. The absence of a unified understanding stemming from the confusion in understanding the circular economy is evident, explaining the firms' indifferences and therefore, its slow uptake.

Resources were central in driving the interests of European Commission, UK Government, the Ellen MacArthur Foundation, UNEP (United Nation Environmental Programme), and several other agencies advocating transition to a circular economy way of doing things. However, there seems to be no agreement on what constitutes 'a circular economy way of doing things'. All these agencies (both private and government) promoting the circular economy inadvertently link it to the three dimensions – economic, environmental, and social. These three dimensions are the three pillars of sustainability (Bocken et al., 2014), also known as the 'triple bottom line' in a business context (Elkington, 1998).

Theoretically, there seems to be a fuzzy and blurred perception about how the circular economy can help gain competitiveness, raising curiosity to find more about the circular economy.

However, the common denominator between all these expressions and advocacy is 'the resources'. The author gained this insight during the familiarisation phase[2] when he attended several Circular Economy events and workshops[3]. In strategic management, 'the resources' are also central to the understanding of inter-firm performance heterogeneity. Firms strive to achieve performance heterogeneity with the sole purpose of securing their future cash flows for prolonged periods. It is primarily about gaining and maintaining competitive advantage within the markets in which the firms operate.

Resources acquisition, accumulation, and allocation play a vital role in achieving a firm's competitive advantage. In this respect, the two theories that resonate well with the circular economy discourses are (a) governance-based theories (GBTs) and (b) competence-based theories (CBTs). GBTs comprises of agency theory, transaction cost economics, and property rights theory. Competence-based theories include the resource-based view, dynamic capabilities, and evolutionary economics (Williamson, 1999). The competence-based theories argue that a firm's resources, acquisition, and allocation, play a vital role in achieving sustained competitive advantage at a firm, regional, and national level. Therefore, possibly CBTs could form the theoretical base and explain how the circular economy facilitates gaining a competitive advantage.

[2] See Appendix 1
[3] See Appendix 4 and 5

There are very few PhD studies in UK Business Schools within the HEA (Higher Education Society) sector that have viewed the circular economy from a business perspective[4] despite the 'thought leaders' highlighting the need for defining specific business values.

Searches in the British Library EThOS (electronic-thesis online service) database for doctoral research on the circular economy, using the keywords 'the circular economy' showed up 54 results as of 13th August 2019. Out of these 54 search results, ten theses were directly linked to the circular economy, and only two doctoral theses were from the business management perspective. The remaining theses were mostly from engineering disciplines, including an entire range of streams, including Metallurgy Engineering; Chemical Engineering, Polymers; Environmental; Design engineering; Industrial symbiosis; Material Use and Productivity. A few were from Legal, Energy Management, Water Resources, and other disciplines (only the first ten theses are shown in Appendix 6). There were none from a strategic management perspective focusing on competitive advantage.

Out of these ten theses, eight were funded, and no information could be gathered for the other two about their funding. Therefore, there is a need for an independent academic enquiry into the circular economy, which this independent self-funded research study fulfils. This PhD study offers insights into gaining a competitive advantage within the circular economy, and, in turn, helps to balance the age-old tensions across economic, environmental, and social dimensions.

[4] See Appendix 6

1.2 Scoping the research investigation

Amongst the economic, environmental, and social dimensions, the economic aspects of the circular economy drive the interest, as businesses evaluate if it makes a business case for them to make investments. Despite the European Commission and the UK government endorsing the circular economy, firms' current indifference signals that it is not making a compelling business case for them. Furthermore, even quantifying the scale of opportunities and the benefits of transitioning to the circular economy is not enough to attract businesses interest (EMF, 2013b, 2014).

Making a business case for businesses to take interest is not new. Several scholars in the past have tried to make a business case for corporate social responsibilities (CSR) (Salzmann et al., 2005; Carroll and Shabana, 2010), as well as making the business case for corporate sustainability (CSD) (Holliday, 2001). The focus has always been to evaluate social engagement, vis-a-vis the firm's financial performance (Moore, 2001). However, there is still considerable scepticism and uncertainty regarding the economic rationale (Walley and Whitehead, 1994). Since the three dimensions are common to both sustainability and a circular economy, we cannot rule out similar scepticism and uncertainty on the part of businesses for a circular economy

Thus far, the circular economy approach has been from the engineering aspect, neglecting the economic part (Zink and Geyer, 2017). The absence of a circular economy competitiveness theory makes it difficult for a practising business manager at the firm level to make decisions that conform to the circular economy. He/she is unaware of where a circular economy begins and ends, including locating his/her firm’s activities in the entire circular chain. Even if a manager understands the circular economy, there is no agreement about how large the circle or the closed loop should be for the business manager to engage. That is, whether it is at a regional, national, or global level. Because, thus far, a circular economy is about addressing issues at a national or global scale. It does not provide specific details of how large, medium, and small firms should formulate their business strategies for a worldwide impact. The involvement of multiple agencies and actors compounds this problem, thereby making the circular economy a non-starter!

Many scholars exploring sustainability and the circular economy such as, Orsato (2006); Orsato and Wells (2007); Park and Chertow (2014); Chertow and Park (2016); Ghisellini et al. (2016); Moreau et al. (2017); Blomsma et al. (2019); Ogunmakinde (2019); Schroeder et al. (2019); Chiappetta Jabbour et al. (2020) as well as leading international organisations such as UNEP(2011); European Commission (2015a); UNESC (2018); PACE (2020), including EMF (2012, 2013b, 2014, 2015a), unanimously agree to decouple economic growth from the consumption of raw material resources. However, both scholars and organisations alike seldom differentiate explicitly between ‘resources use’ and ‘natural raw material resources use’. Additionally, the lack of a unified understanding of the circular economy could stem from a dearth of a more in-depth empirical study that does not merely scratch the surface but digs deeper to identify mechanisms and structures that can be leveraged for facilitating a coherent and uniform understanding of the circular economy.

Therefore, **this research study aims to investigate** the circular economy in UK manufacturing firms and the government agencies responsible for preserving the environment and natural resources. It seeks to find out how the automotive and IT firms and government agencies understand, construct, and operationalise the circular economy for achieving competitive advantage. It also assesses if the resource-based view’s (RBV), VRIN framework is suitable for a firm participating in a circular economy.

The objectives that stem from the aim are to (a) explore the nature and characteristics of the circular economy, and (b) investigate how these impact the firm’s use of resources for achieving competitive advantage.

The research questions that would help to address the aim and objectives are:

RQ1: What best describes the current understanding, construction, and operationalisation of the circular economy by UK manufacturing firms, and government agencies?

RQ2: How do firms manage waste?

RQ3: How does the understanding of the circular economy affect the characteristics of resources required for achieving a competitive advantage within circular economy environments?

RQ4: What are the policy implications of the circular economy influencing the use of resources?

The study uses a working definition of the circular economy drawn from resources and capabilities literature to answer the above research questions. The author speculates a circular economy to be a dynamic capability because it is considered a panacea by private and government agencies and thought to bring about a change. Therefore, the working definition of this research study is as follows:

> ‘The circular economy is a dynamic capability that purposefully, creates, extends, and modifies a firm’s resource base’ Helfat et al. (2007 p. 4); Helfat and Peteraf (2009).

This research study employs the working definition and a critical realist lens to access the circular economy's ontological knowledge to identify its nature and characteristics.

Critical realism is chosen because it offers a general orientation to research practice, providing concepts that help create an accurate explanation of the object/entity/phenomenon of study. It accepts that some views of the object/entity/phenomenon are more accurate than others. Also, it seeks to identify the generative mechanisms or causalities that are at work.

Therefore, the author considers Critical Realism fit for investigating the circular economy because, (a) it is described differently at different times, by different public and private agencies, and there is no clarity regarding its theoretical base. It means some descriptions of the circular economy are more accurate than others. Also, (b) if the causality of the confusions and conflation can be identified, it would help resolve them to foster a coherent and unified understanding of the circular economy and establish its theoretical base. As a result, the research process is methodologically plural and iterative. It allowed the author to gain insights about the circular economy by attending its events and workshops during the familiarisation phase before engaging with the literature.

The author identified that 'the resources' are central to the circular economy through fieldwork and conducts a standard review of both the circular economy and resources and capabilities literature. The other choice on offer was conducting an immanent critique, which is essentially about critiquing from within the theoretical position, thereby identifying contradictions, ambiguities, and inconsistencies to delve. Since the circular economy does not have a clear-cut theory, the author adopted the former following the process explained below (O'Mahoney and Vincent, 2014 p. 14)

1. In the first step the author endeavours to distinguish the more realistic from less realistic theorising of the circular economy by undertaking a literature review focusing on the historical analysis of the sustainable development because it also addresses the economic, environmental, and societal dimensions similar to the circular economy

2. The first step enables the author to ascertain the mechanisms and contexts that could be underplaying in the understanding of the circular economy.

3. It allowed the author to identify the gaps concerning the interplay of mechanisms and contexts that merits further study.

The research questions were formulated from these three steps, which helps to develop the research design. It was followed by data collection and rigorous analysis of the data. The research questions are answered based on the data analysis and using systematic combining of both inductive and deductive logic.

1.3 The research process and structure of the thesis

The research process was not linear and sequential, as is shown in Figure 1-1 below, but it summarises the flow of thesis.

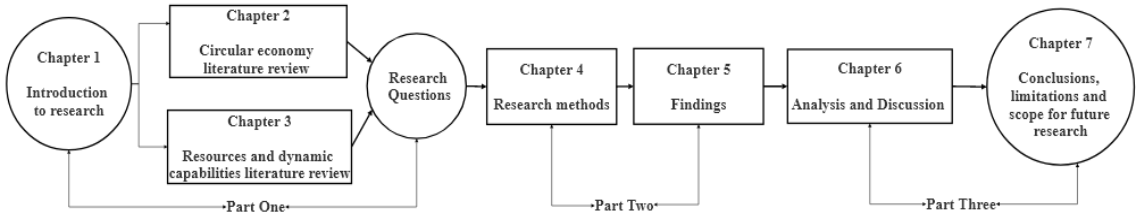

Figure 1-1: Research process and thesis structure

The thesis is in three parts. Part one is comprised of Chapters 1, 2 and 3. Chapters 4 and 5 make Part two, while Part three consists of Chapters 6 and 7.

In part one, Chapter 2 reviews the literature on the circular economy. Practitioners have primarily promoted a circular economy, linking it to the UN Sustainability Programme's economic, environmental, and societal dimensions. This chapter traces the antecedents of the circular economy in sustainable development literature. It explores all those theories/ concepts/ models/ frameworks that link to or are used to facilitate understanding of the circular economy. While exploring these, it also finds mechanisms in play and shaping the circular economy's current understanding. It helps identify the theories/ concepts/ models/ frameworks and emerging factor(s) and absences that this research investigates further.

Chapter 3 forms the theoretical base on the circular economy, identifying strategic management theories that explain the impact of the emerging factor(s) found in Chapter 2. It engages with the literature of existing resource-based theory, and dynamic capabilities view to find their relevance for achieving competitive advantage in the context of the circular economy. It also isolates factors that need testing in real-time business settings.

The aim, objectives, and research questions for this investigation result from the literature review in Chapters 2 and 3. The conceptual framework and seven steps also emerge from the literature review, providing a structured approach for conducting an empirical investigation, organising the data, and addressing the research questions.

The second part of this research study starts with Chapter 4 and ends in Chapter 5. Chapter 4 explains the critical realist case study strategies and techniques that this research adopts to investigate the circular economy. It starts by providing reasons for choosing critical realism. It then briefly describes the critical realist tools that this research uses to analyse the empirical data gathered from the automotive, IT, and government sectors. This chapter also explains the contexts of the different types of data collected, its analysis, and the ethical considerations that this research pursued.

Chapter 5 reports the lived experiences and the circular economy's understandings in the automotive, IT, and government sectors. It follows the seven steps that resulted from the conceptual framework from the literature reviews in Chapters 2 and 3. It gives a detailed account of each interviewee's understanding of the circular economy from across the automotive, IT, and government sectors.

Chapter 6 deals with answering the research questions by analysing and discussing the participants' lived experiences, captured through semi-structured interviews. In this chapter, firstly, a comparison is made between different individual accounts of the same sector. Then, cross-comparison and contrasting individual accounts between the three sectors are conducted to produce a rich explanation of the circular economy's understandings. It identifies the most realistic concept that describes the circular economy. After that, it lays down the impact that circular economy understanding has on organisational resources, and it identifies the emerging trends for competing in a circular economy business ecosystem.

Chapter 7 presents the conclusions, discussion and theoretical contributions, and managerial implications that this research study makes, highlighting limitations and suggesting possible future research opportunities.

Chapter 2 A literature review of the circular economy

2.1 Introduction

The purpose of this chapter is to capture the various influences, from different disciplines of knowledge and their sub-disciplines, that are currently in use to understand a circular economy. As a result, this chapter explores both academic and non-academic literature used for understanding the circular economy. The non-academic sources include reports published by NGOs, consultancies, environmentalists, and social activists. They believe in a world where everyone can participate in creating a better future. While carrying out this review, the endeavour has been to identify the most realistic theories/ concepts/ frameworks that best describe the circular economy. This will, in turn, help to locate the overlaps, absences, and causal mechanisms that are in-play, thereby shaping the current understanding of the circular economy.

Currently, the circular economy is often confused with different concepts that are referred to or treated as close cousins. The concepts that are often considered at par with the circular economy despite them being not necessarily circular are 'Collaborative economy' (Huber, 2017); 'Green economy' (D'Amato et al., 2017) (Prieto-Sandoval et al., 2018); 'Collaborative Commons' (Botsman and Rogers, 2010; Botsman, 2014; Martin, 2016; Bradley and Pargman, 2017); 'On-demand economy'(Schroeder et al., 2019); 'Circle economy'(PACE, 2020); 'Performance economy' (Stahel, 2006); 'Gig economy' (Martin, 2016; Frenken and Schor, 2017); 'Sharing economy' (Frenken and Schor, 2017; Lazarevic and Valve, 2017; Reike et al., 2018); 'Access economy' (Schor, 2017); 'The mesh'(Preston, 2012; Martin, 2016) 'Hippienomics', 'Enabling economy', 'People economy' (Botsman, 2014), and 'the Blue economy' (Pauli, 2010).

Additionally, the circular economy has been considered as; (a) 'a new sustainability paradigm' (Geissdoerfer et al., 2017); (b) a resource efficiency strategy, and/ or a development strategy (UNEP, 2006; Yuan et al., 2006; Geng and Doberstein, 2008; Lee et al., 2012; EMF, 2013b; Bocken et al., 2017a); (c) a closed loop model for 'restoration of biological and technical nutrients' - Cradle to Cradle' framework (Braungart and McDonough, 1998, 2008; Guide and Wassenhove, 2009; Bocken et al., 2016; Lieder and Rashid, 2016); and (d) another framework for 'Environmental sustainability' (Sauvé et al., 2016; Korhonen et al., 2018a).

The circular economy is thought to be (a) inspired by 'bio-mimicry' design (Benyus, 1998; Benyus, 2002; Swiegers et al., 2012), (b) facilitated by 'circular supply chains' (Bin et al., 2017; Batista et al., 2018), and (c) 'Industry 4.0 (Lopes De Sousa Jabbour et al., 2018; Rajput and Singh, 2019) – these are a few out of the many conceptions that are currently in use for understanding the circular economy.

Similarly, different disciplines linked to the circular economy are: (a) industrial symbiosis, (b) eco-industrial parks, (c) closed-loop cycles, (d) cleaner production, (e) green operations, (f) renewable energy and energy efficiency, (g) product-life extensions, (h) design thinking, (i) systems thinking, (j) Industry 4.0, (k) technology platforms, (l) waste-trade markets, (n) zero waste programmes, (m) municipal solid waste management, and many more.

Against this backdrop, a good point to start the investigation about how the current understanding of the circular economy is shaping up would be to carry out a historical analysis, and then to distinguish more realistic from less realistic theorising of the circular economy. This process would help in identifying mechanisms and the gap in between the interplays that warrant further study.

Accordingly, this chapter proceeds as follows: the next sub-section 2.2 is about antecedents attempting to track the empirical evidence of the circular economy within the historical roots of sustainable development. Similarly, sub-section 2.3 identifies empirical traces within different disciplines and sub-disciplines linked to the circular economy. Sub-section 2.4 studies the waste hierarchy, and the new term ‘the zero-waste circular economy’. This sub-section also studies the relationship between technological advancements, primarily Industry 4.0 and the circular economy. Sub-section 2.5 analyses the various circular economy definitions. Sub-section 2.6 discusses epistemological issues with the circular economy, thereby laying down the aim, objectives, and research questions in sub-section 2.7. The chapter ends with a conclusion presented in sub-section 2.8.

2.2 The antecedents of the circular economy narrative

The most realistic concept for the circular economy is ‘the sustainable development’ (WECD, 1987) concept because it also focuses on the three dimensions (economic, environmental, and social') that the circular economy does.

Du Pisani (2006) adopts a longue durée approach to find the historical roots of 'sustainable development', whereas Reike et al. (2018) uses the ‘umbrella concept’ (Braudel, 1982; Hirsch and Levin, 1999) as an analytical lens to find the antecedents of the circular economy (Blomsma, 2016). The umbrella concept treats the circular economy as a 'resources’ life-extending strategy,’ from the policy perspective, and traces its antecedents to the second industrial revolution (Zhijun and Nailing, 2007; Reike et al., 2018).

Since this study situates itself within strategic management, adopting a longue durée[5] approach would offer a better explanation regarding the current structure and conduct of the circular economy. Also, because of the dimensional similarities between both, it could reveal issues subsumed under the term 'the circular economy'. Therefore, the author uses both approaches to identify (a) the empirical traces of the circular economy in the historical roots of sustainable development, and (b) for understanding the nature of life-extending strategies.

- ***Geographical penetration of the circular economy concept***

Murray et al. (2015) inform us that the circular economy concept is found in the literature emanating from different geographical regions such as Australia (Roberts, 2004; Giurco et al., 2011); Austria (Lesjak, 2008); Belgium (Huybrechts et al., 1996); Brazil (Milanez and Bührs, 2009); China (Chen, 2009; Chen et al., 2009; Liu et al., 2009; Zhu and Geng, 2013); Egypt, Middle-East North Africa (E-MENA) region; (Sakr et al., 2011); Finland (Gibbs and Deutz, 2007; Korhonen and Seager, 2008; Korhonen et al., 2018b); Germany (McKenna et al., 2013); Indonesia (Jupesta et al., 2011); Malaysia (Ludin et al., 2014); Japan (Berkel et al., 2009) Portugal (Costa and Ferrão, 2010); UK (Pearce et al., 1989; Pearce and Turner, 1990; Gibbs and Deutz, 2007; Allwood et al., 2011); USA (Braungart and McDonough, 2008; Richa et al., 2017). This demonstrates the global footprint of the circular economy, making it more complex and challenging to understand.

- ***Disagreements concerning the circular economy term***

There are diverse views regarding who first coined the term 'circular economy'. According to Ghisellini et al. (2016 p. 14); Geissdoerfer et al. (2017 p. 759); Lieder and Rashid (2016 p. 43); and Li et al. (2013 p. 1552), two British environmentalists, Pearce and Turner (1990), coined the term.

Murray et al. (2015) informs us that Pearce and Turner (1990) claimed the use of the 'circular economy' term for describing the close interaction between the economy and the environment. It appeared in the western literature for the first time during the 1980s.

However, Liu et al. (2009 p. 265) and Yuan et al. (2006 p. 4) argue that 'the circular economy' is a Chinese concept. The Chinese scholars were the first to present it in 1998, to their government. As a result, the Chinese government adopted it in 2002 as their new development

[5] Longue durée – is a French word used by historians to illustrate their approach to historical writings. The crux of the longue durée approach is that it not only gives priority to long-term structures, but also focuses on slowly evolving structures and substitutes. It goes beyond history examining beneath the surface of structures and cyclical periods of time, old attitude of thoughts and action. In short, it looks for 'evental history' (Wesseling, 1981; Braudel and Wallerstein, 2009).

strategy (Geng and Doberstein, 2008; Geng et al., 2009; Geng et al., 2012; McDowall et al., 2017).

- ***Disagreements in the conceptualisation of the circular economy***

The idea of circularity seems to have arisen from Boulding's (1966) description of the closed system, quoted below:

'In a closed system, the outputs are linked to the inputs of other parts. There are no inputs from outside and no outputs from the inside; indeed, there is no outside at all. Closed systems are scarce in human experience, in fact almost by definition unknowable…' (Boulding, 1966, p. 2).

Greyson (2007) argues that Boulding is referring to 'the circular economy' in this quote, describing the circular economy as a long-term aim, compatible with economic growth, sustainability, and zero-waste. Skene (2017) counters Greyson's argument, citing that the Earth is not a closed spaceship as described by Boulding (1966), but an open system that relies on vast rivers of energy flowing through it. Skene (2017) argues that the circular economy relies on tight loops, zero wastes over extended lifetimes, and closed systems. Portraying nature as a perfect cube where no waste happens, based on Boulding's (1966) 'Garden of Eden' fantasy, can never deliver sustainability.

EMF (2013b, 2014, 2015a) in order to explain the benefits of the circular economy has compared it to a linear economy. The EMF has conceptualised the linear economy as an economic system based upon the 'input-output systems' analogy. That is, the linear economy is about the extraction-production-consumption-disposal approach, where the focus is on the management of throughput flows (Greyson, 2007; Chertow and Park, 2016). Murray et al. (2017) argue that comparing or linking the circular economy to a linear economy to explain the superiority of the circular economy is confusing because their contexts differ.

The 'linear' system is in the context of national growth, and is a model describing the successive stages that a nation goes through, set out by Rostow (1960). The 'linear' term in economics is for linear economic modelling, which is a mathematical model used to analyse economic behaviour and has nothing to do explicitly with the economics of circularity (Murray et al., 2017).

The circular in mainstream economics relates to 'the circular flow of income.' It explains exchanges in an economy through flows of money, goods, and services between economic agents, and forms the basis of the economico-political systems. The circular flow of income does not deal with resource efficiency or the end-of-life strategies that a circular economy does.

The only connection the circular flow of money has with the circular economy is through Jevons' paradox or rebound effect, which is a result of achieving resources' efficiency. Richard Cantillon, who first presented the idea of a circular flow of money, influenced the works of William Stanley Jevons. The Jevons paradox and rebound effect are actively discussed in the circular economy literature (York and McGee, 2015; Moreau et al., 2017; Zink and Geyer, 2017; Korhonen et al., 2018b).

The entire credit for developing the circular flow of money went to Francois Quesnay and his famous work 'Tableau économique'. It has its roots in the works of Richard Cantillon (Murphy, 1993 pp. 47-48). However, many sustainability scholars such as Lumley and Armstrong (2004), Melgar-Melgar and Hall (2020), and a few circular economy scholars such as Murray et al. (2017), do not recognise Richard Cantillon. They consider the origins of the 'input-output system' currently used to explain the circular economy to have been derived from the 'Tableau économique'. They argue that it was Quesnay and not Cantillon who theorised that the Natural law composed of physical and moral laws transcending 'human beings' free will' drives the economy (Quesnay, 1765).

Thus, 'the circular economy term' presents the most abstracted level of descriptions, making it complex to understand, and seemingly difficult to operationalise.

2.3 Identifying empirical traces of the circular economy in the historical roots of sustainable development

The awareness of the imminent ecological crisis emerged around the end of the twentieth century, leading to the urgency of addressing the planetary limitations of the Earth. It resulted in sustainable development becoming a mantra pervading all international and national governments' policies. Thus, the 'World Commission on Environment and Development' set this agenda in 1987 (Sjåfjell et al., 2017):

'Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WECD, 1987) also known as Brundtland (1987 p. 42) report.

The literal meaning of 'sustainable' is 'lastingness', found in French (durabilité and durable), German (nachhaltigkeit) and Dutch (duurzamheid and durrzaam) works of literature. It was included in the Oxford English Dictionary during the time of realisation of ecological crisis, although already used for centuries (Van Zon, 2002 pp. 20, 21, 22).

The issue of availability of natural raw material resources and the environmental impact of its extraction has been an issue throughout human history (Van Zon, 2002; Du Pisani, 2006). Environmental problems were a part of the ancient Egyptian, Mesopotamian, Greek, and Roman civilisations. The deforestation, salinisation and loss of soil fertility of ancient times are also today's sustainability issues. Similarly, 'Plato in the 5th century BC, Strabo, and Columella in the 1st century BC, and Pliny the Elder in the 1st century AD discussed different types of environmental degradation resulting from farming, logging and mining'. They even suggested ways to protect the 'everlasting youth of the Earth' (Elder, 1938; Strabo, 1944; Columella, 1948 Res rustica.; Du Pisani, 2006 p. 85). La Freniere (1990) traces sustainability to the 18th century works of Jean-Jacques Rousseau, which is about steady-state economics operating under within the environmental ethics of humanity's harmony with nature.

Protecting the environment and reserves of natural resources in order to improve upon this world has its roots in faith philosophies as well. The belief that virtuous actions on Earth are in preparation for a better life in the hereafter drives such actions. These led to deontological and utopian ideas underpinned by Christian philosophy contributing to the ideas of progress and growth. Progress became ''a secularised heir to the Christian ideal of salvation'' (Von Wright, 1997 p. 5; Dawkins, 2015). Thus, the 13th century saw the establishment of the idea of human progress in Europe. It stemmed from (a) 'awareness of the cumulative advancement of culture and (b) a belief in a future golden age of morality on this earth' (Nisbet, 1980 p. 77 & 100).

Sustainable development has its roots in the 18th century's new ways of thinking. For example, it is promoting the responsible use of natural resources reserves in the interest of present and future generations as a part of new ways of thinking. This thinking resulted from overconsumption of wood as it was the primary source of energy and also extensively used in construction (Van Zon, 2002 pp. 19, 20, 55, 56, 58-66). During this time Hans Carl von Carlowitz wrote 'Slyvicultura oeconomica' (von Carlowitz, 1713), based on the silvicultural principle that the amount of wood harvested should not exceed the volume that grows again. The silvicultural principle has been in use in today's ecology discipline, which is one of the building blocks of sustainable development.

Sustainable development is also rooted in the 'need principle' that stemmed from the works of Thomas Robert Malthus (1798). Malthus' famous work on 'principles of population growth' resulted from the fear that excess population growth might lead to outstripping food production and depletion of the reserves of natural resources. The 'Need Principle' later formed the basis for 'equity'. The need principle's core belief is that all humans have the right to some essential core needs, i.e. food (Ikeme, 2003).

Similarly, William Stanley Jevons raised concern about the depletion of English coal reserves, when the focus of energy shifted from wood to coal. The need for energy conservation in today's sustainability discourse is rooted in Jevons' work 'The Coal Question, 1866'. He stressed saving energy, thereby putting 'the welfare' on the public agenda for good. Jevons' paradox stems from achieving resource efficiency. That is, producing the same amount by using fewer resources and consuming less energy with fewer wastes and emissions results in lowering production costs. It prompts manufacturers to lower the prices of their products. Low prices, in turn, increase the consumer's purchasing power, and they start to consume more. More consumption leads to more production. The net effect is an overall increase in energy use that negatively impacts the environment. This is also called a 'rebound effect', and is discussed actively in the circular economy literature, in the context of eco-efficiency (Korhonen, 2005 'p. 97; Korhonen and Snäkin, 2005; Orsato and Wells, 2007; Bocken et al., 2017b; Ness and Xing, 2017).

Sustainable development, as mentioned in Brundtland (1987), has its root in political economy too. For example, George Perkins Marsh (Man and Nature, 1864) raised concerns about the different aspects of the natural environment being destroyed due to human interventions. He argued that the Earth would become unfit for humans, leading to the extinction of human beings. Marsh did not want to protect the natural environment just for its own sake, but for future generations. He also offered possible remedies for environmental issues created by humans. The intergenerational equity within sustainable development possibly stems from Marsh's (ibid) work (Du Pisani, 2006).

After coal, when oil became the primary source of energy in the early twentieth century, a drastic increase in oil consumption and dependence on fossil fuels raised alarms. Prominent scientists and economists of the time, such as Thorstein Veblen (1917) and AC Pigou (1929) and many others, warned about the limited reserves of natural raw materials resources and its wasteful consumption (Van Zon, 2002 pp. 103-110). The Industrial Revolution between the 1950s and 1970s saw a steep increase in production, consumption, and wealth accumulation. The neo-classical economists, though aware of the impending scarcity of natural raw material resources, relied heavily on technology, thinking new technologies would economise the scarcity. After the two world wars, globally, societies witnessed moral degradation, materialistic progress, and comfortable living. Technological and scientific progress further aggravated environmental degradation, making it an urgent issue for international and national governments worldwide. During this time, Rachel Carson, a biologist, published her famous work, Silent Spring (1962), which highlighted how pesticides (DDT) damaged the natural environment (Carson, 1962). Similarly, Fritz Schumacher's Small is Beautiful (1973) and many other books highlighted ecological disaster, calling for saving the natural raw material resources as well as the environment.

All this while, the focus was on saving the reserves of natural raw material resources, and the environmental impact caused because of its unmindful consumption.

Following the oil crisis and the global recession of 1974-76, the need to protect natural raw material resources reserves grew even more substantially. A group of well-known eminent scientists and economists came together to form ‘The Club of Rome’, and published ‘The Limits to Growth’. They linked technology-led industrialisation, pollution, population growth, food production, the limited supply of physical natural raw materials resources, and its depletion. They warned that if such growth continues unchecked then it could end up as a catastrophe (Meadows et al., 1972 p. 23).

The other two dimensions of sustainable development, i.e. economy and social equity, were included with the conservation of natural raw material resources and environmental protection discourses. In Gladwin’s expression ‘modern management theory is constricted by a fractured epistemology, which separates humanity from nature and truth from morality.’ ‘A reintegration is necessary if organisation science is to support ecologically and socially sustainable development’ argues Gladwin et al. (1995 p. 874) and Russo (2003 p. 326). Thus, rejecting technology-led development and advancing the case for ‘sustaincentrism’. That is, there is an urgent need to look at sustainable development more holistically.

Thus, based upon the above discussions, we can conclude that the circular economy is not a new concept as it is being currently projected. The conclusion results from considering the circular economy’s global footprint, the disagreements about its origins and conceptualisation, including empirical traces of it in the historical roots of sustainable development. Similarly, the depletion of natural raw material resources has been an issue throughout human history.

The other identifiable empirical traces of the circular economy from the history of sustainable development are (a) ecological economics emerged as the overarching theme in understanding a circular economy, (b) a reliance on technological developments underpinned by innovation to address the scarcity of raw material resources emerged as the second dominant theme; although it also evidenced (c) the causal mechanisms of environmental degradation, i.e. wealth accumulation achieved through high production and consumption; and (d) a conspicuous dimming or absence of the responsible deontology narrative underpinned by faith philosophies, utopias and value systems about safeguarding the environment for doing greater good, linking it to earning rewards in the hereafter.

As a result, the next closest ecology models/ frameworks that are in use to understand the circular economy are; (a) industrial-ecology (b) industrial symbiosis (c) eco-industrial parks (d) closed-loop materials cycles, and (e) greening supply-chain.

2.4 Identifying empirical traces of the circular economy in existing concepts, models, and frameworks

This section, therefore, traces a circular economy within ecological economics; industrial ecology; industrial symbiosis; eco-industrial parks; closed-loop frameworks; design thinking and related frameworks/ concepts.

The circular economy seems to have attracted more attention from the industrial ecology community than within the ecological economics (Bruel et al., 2018 p. 13). According to Daly (1985); Daly and Farley (2004) and Costanza (1991) ecological economics provide a general framework to study economy-society- environment. Cleveland (1999) argues that both industrial ecology and ecological economics are representations of the bio-physical economy (Cleveland, 1999), and there are overlaps between these two fields (Korhonen, 2005; Kronenberg and Winkler, 2009). Similarities between industrial ecology and ecological economics are that both focus on maintaining socio-economic activities within environmental limits. Both are interdisciplinary in adopting a systems approach and use input-output analysis. Both share an interest in physical flows rather than in real monies. However, ecological economics is more holistic, as opposed to industrial ecology. Ecological economics sees the natural system as a stock of natural capital generating the flows for ecosystem services. The similarities between both link them to sustainable development (Bruel et al., 2018 p. 16).

- ***Industrial ecology (IE)***

Industrial ecology is central to sustainable development argues Ehrenfeld (2004b, 2004a), and Goodland (1995); Goodland and Daly (1996) are of the view that environmental sustainability being central to achieving the economic and social sustainability led to the development of industrial ecology as a separate field of study. They consider IE as a broad approach to deal with the anthropocentric industrial activities exploiting the reserves of natural resources. It causes long-term negative environmental impacts due to unlimited resource-use and pollution (O'Rourke et al., 1996). For finding solutions to the negative environmental impacts, many scholars thought of taking inspiration from biological systems in order to develop industrial ecosystems that are self-sustaining. This thought led to the development of the industrial ecology field of study, and its related sub-fields such as industrial symbiosis, industrial metabolism, and legislation and regulations to support industrial ecology development and applications (Tibbs, 1993).

There are several definitions of industrial ecology provided by different scholars. They refer industrial ecology to different methods, approaches, designs, frameworks to design and transformation of industrial systems to nearly closed-loop industrial ecosystems. However, considering industrial ecology as just another framework or an approach limits its development and applications argues Li (2018).

Frosch and Gallopoulos (1989) the proponents of IE, explained the idea of the industrial ecology in various ways, e.g. 'the industrial ecosystem would function as an analogue of biological ecosystem' (1989 p. 144). They elaborated their statement to mean: 'the traditional model of industrial activity in which individual manufacturing processes take in raw materials and generate products to be sold plus waste to be disposed of, should be transformed into a more integrated model: an industrial ecosystem. In such a system the consumption of energy and materials is optimised, waste generation minimised and the effluents of one process whether they are spent catalysts from petroleum refining, fly and bottom ash from electric-power generation or discarded plastic containers from consumer products serve as the raw material for another process.' (1989 p. 144), and explained further by citing this example: 'Materials, in an ideal industrial ecosystem, are not depleted any more than those in a biological one is; a chunk of steel could potentially show up one year in a tin can, the next year in an automobile and ten years later in the skeleton of a building. Manufacturing processes in an industrial ecosystem simply transform circulating stocks of materials from one shape to another; the stocks in circulation decrease when some material is unavoidably lost, and it increases to meet the needs of a growing population. Such recycling still requires the expenditure of energy and the unavoidable generation of wastes and harmful by-products, but at much lower levels than are typical today' (1989 p. 145). Allenby (1999) argues that industrial ecology is in a state of flux just as is a natural ecosystem.

In a nutshell, this means that industrial ecology is about industrial ecosystems that mimic biological ecosystems. It integrates various industrial activities, optimises the consumption of the raw materials resources and energy, and minimises waste, through closed-loop linkages between the various industrial processes. Such an ecosystem contains linkages between cooperation and competition (O'Rourke et al., 1996 p. 92).

It was Barry Commoner who, in his book, The Closing Circle (1971), laid down the 'laws' of ecology. He argued that 'if we are to survive economically, as well as biologically. Then, industry, agriculture, and transportation will have to meet the inescapable demands of the ecosystem.' These ecosystem demands include 'essentially complete containment and reclamation of wastes. These ecosystem demands include essentially complete recycling of all reusable metal, glass, paper products; [and] ecologically sound planning to govern land use.' (Commoner, 1971 p. 282; O'Rourke et al., 1996 p. 92).

Tibbs (1993) describes the principles of industrial ecology as follows:

1. Creating industrial ecosystems that are logical extensions of the life-cycle thinking, moving from assessment to implementation, and involving ‘closing-the-loops’ by recycling and treating waste as raw material.

2. Dematerialisation of industrial output – use fewer virgin materials and energy by becoming more resource-efficient.

3. Improve the efficiency of industrial processes – redesign products, processes, and equipment.

4. Pursue increased utilisation of energy and substances (i.e. water, material by-products and wastes) through cascading. Cascading helps in transforming resources is some productive use. However, the resources do not return to their original virgin-like state. The exchange of substances can resemble a web-like structure if many exchanges are involved (Korhonen and Snäkin, 2005).

5. Align policies with the industrial ecology concept; incorporate the environment and economics to the firm, regional, national, and international policies. Internalize the externalities (Lowe and Evans, 1995).

These principles de-link economic growth from resource conservation and environmental protection. The norms emanating from industrial ecology are connectedness, cooperation, and community-ness. It contradicts mainstream neoclassical economics (Ehrenfeld, 2000, 2004b, a). Industrial ecology exists in three levels; (a) intra-firm or micro-level (within an organisation); (b) inter-firm or meso level (involving a group of companies or at industry level); (c) macro or regional level including nationally and globally. At the micro-level, or at the individual firm level, industrial ecology incorporates concepts such as clean technology, cleaner production, life cycle assessment, green chemistry, and design for environment (DfE). Clean technology is an economically competitive and productive technology that aims to use less material/ energy, to generate less waste that, in turn, causes less environmental damage (Clift, 1995). UNEP in 1990 defined cleaner production as ‘the continuous application of an integrated environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment’ (UNEP, 1990).

- ***Industrial symbiosis (IS)***

Industrial symbiosis is the sub-field of industrial ecology. Industrial symbiosis focuses on the flow of materials and energy through local and regional economies (Chertow, 2000 p. 313). The difference between industrial ecology and industrial symbiosis lies on the scale. Industrial ecology focus is on local, regional as well as global economies, whereas industrial symbiosis is only at a local and regional level. Industrial symbiosis focuses on 'inter-firm level because it includes exchange options among several organisations' (Chertow, 2000 p. 314). Domenech et al. (2019) argue that IS can potentially help transition to a circular economy.

In industrial symbiosis, traditionally separate industries and entities come together in a collaborative approach for sharing resources. This, in turn, benefits the environment and the economy (Chertow and Park, 2016), in a manner that matches 'industrial input/ output to the real limits of Earth's carrying capacity' (Lowe and Evans, 1995). Chertow (2007) has defined industrial symbiosis as 'engaging traditionally separate industries towards a collective approach for competitive advantage, involving a physical exchange of materials, energy, water, and by-products'. The keys to industrial symbiosis are collaboration and synergistic possibilities offered by geographic proximity'. Industrial symbiosis endeavours to create economic as well as environmental benefits. Desrochers and Leppälä (2010) explain industrial symbiosis as 'a concept used to describe geographically proximate inter-firm relationships involving the exchange of residual materials, water, and energy'. Domenech and Davies (2011) and Domenech et al. (2019) describe industrial symbiosis coming out of industrial ecology, and 'as a body of exchange structures to facilitate progress to a more eco-efficient industrial system. By establishing materials and energy exchanges among different organisational units, IS networks aim to reduce the intake of virgin materials and lower the production of waste by the industrial sector'.

An example of industrial symbiosis found in the small Danish city of Kalundborg is represented in Figure 2-1 below. Here, numerous bilateral, gradual, voluntary and economically profitable residual and energy linkages were created over three decades between local businesses that included a refinery, a power plant, a pharmaceutical plant, an aquaculture operation, the local city administration, a wallboard manufacturer and nearby agricultural producers. For example, fertiliser plants use sludge recovered from pharmaceutical processes. Residual steams from the power plants are channelled to the refinery, which in exchange, pipes back refinery gas previously flared as waste. Gypsum produced by the power plant's desulphurisation process is sent to the company producing wallboard, and a cement company uses fly ash from the power plant. Kalundborg symbiotic linkages, a few years ago, was estimated to comprise of some 2.9 million tons of materials recycled annually and to have reduced local water consumption by 25 per cent (Desrochers and Leppälä, 2010 p. 342).

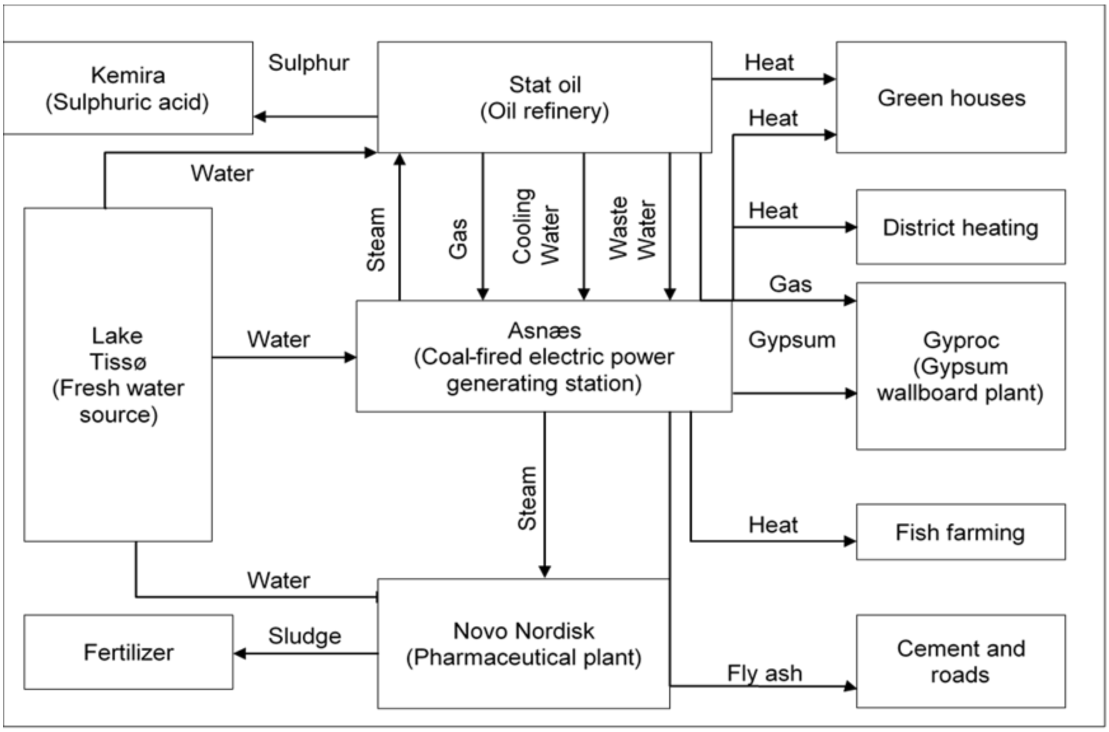

Figure 2-1: The flow of resources and by-products between different firms in the pioneering industrial ecosystem of Kalundborg in Denmark. Source: Novo Nordisk (Tibbs, 1993 p. 11)

Domenech and Davies (2011) argued that a web of knowledge is essential for facilitating the establishment of physical exchange of resources and its wastes among diverse organisations. This has led to the realisation of the importance of knowledge in industrial symbiosis development and the need for industrial symbiosis systems boundaries. Accordingly, industrial symbiosis requires the integration of the following features (Li, 2018 p. 20):

1. Web of knowledge
2. A network of diverse organisations
3. Novel sourcing of inputs
4. Value-added destinations of non-product outputs (and further end-of-life products)
5. Improved business and technical processes, and
6. It is a collective approach of a system as a whole.

- ***Eco-industrial parks***

The central government of China has made the circular economy a national regulatory policy (Geng et al., 2012). Therefore, Chinese circular economy journal articles do not debate much about the circular economy concept but instead examine the practical implementation issues. In China, operationalisation of the circular economy is mostly in the form of 'Eco-Industrial Parks[6] (EIPs)' (Chiu and Yong, 2004). These EIPs comes in various forms and shapes and endeavour to operationalise the circular economy concept, which is evident from the statement – '…A consensus reached… emphasises the benefits of utilising residual waste materials, including energy, water, different by-products…a most common example would be industrial symbiosis where collective benefits come from both economic and environmental aspects…'(Su et al., 2013 p. 216). As a result, the drivers, and barriers to implementing EIPs could help in understanding the operationalisation of the circular economy (Jacobsen, 2006; Yuan et al., 2006).

- ***Closed-loop concept***

Closing the loop is about bringing raw materials, resources and energy used in different production processes back for use again either by the same set of players or by an entirely different set of players. It is through closing the loop that industrial ecology and industrial symbiosis concepts are realised (Li, 2018). The closed-loop concept is of interest to the academics and practitioners studying the circular economy, because it drives sustainability issues in supply-chain operations/ operations management, allowing for optimising of the raw materials resources flows for achieving environmental and economic sustainability.

According to Bocken et al. (2016) and Stahel (2006) resources flow may be (a) made low, i.e. increase resource efficiency or, (b) slowed (i.e. designing longevity in products or extending the life of the product either through repair, re-using or remanufacturing) or (c) closed, i.e. the loop between post-use and production process is closed.

In the circular economy literature, there is a discussion of three types of loops, namely (a) closed-loop cycles (b) open-loop cycles, and (c) closing the loops on both sides.

(a) Closed-loop cycles relate to the logistics of moving unwanted (scrap) raw material resources (arising during production, or harvesting end-of-life/ used products and components), from one part of the overall value chain to an appropriate point in the original supply-chain for processing. It often happens within the firm's supply-chain network. (b) An open-loop cycle is about moving

[6] EIP: Eco-Industrial Parks are known by different acronyms such as EIN- Eco-Industrial Networks; EID: Eco-Industrial development ; NEIP: Networked eco-industrial Parks; IEIP: Integrated eco-industrial Parks; Industrial ecosystem; Industrial symbiosis – Source: Chiu and Yong (2004).

unwanted (scrap) raw material resources outside the original or firm's supply-chain network. Usually it is for use in different types of processes (Ortiz et al., 2010; Geyer et al., 2016; Batista et al., 2018). (c) Closing the loops from both ends is an integrative effort. It is about closing not only the output of production and consumption (the product coming back into production after being used) , but also the input (mining of raw material resources) that goes into the production(Nilsen, 2019 p. 32).

The idea of closing the loop extended the closed-loop concept to the supply-chain management discipline, giving rise to the closed-loop supply chain management academic stream (Guide and Wassenhove, 2009), and gained prominence after 2008 (Govindan et al., 2015 p. 604).

Since closed-loop in general addresses the negative impacts of production and consumption, such as resource depletion, and excessive wastes generation, it has been regarded as a subset of operations management and sustainable supply chain management. In this sub-field, four kinds of literature have appeared. These are reverse logistics, green supply chains, sustainable supply chain management (SSCM), and closed-loop supply chain (Batista et al., 2018 p. 438).

Reverse logistics is concerned with the reverse flow of finished products, i.e. bringing back used products either at the end-of its-first life/ first use, or directly from consumers to producers.

The green supply chain mostly focuses on greening the entire production and distribution processes, i.e., integrating green purchasing to the extraction of raw materials resources. It also involves following grow green policy for growing food (to keep soil fertility lasting longer), supplier process improvements in line with reducing waste, and CO2 and GHG emissions including green accreditation of suppliers.

Sustainable supply-chain management is mostly concerned with the triple bottom line approaches to supply-chain management, and integration of economic, social, and environmental capabilities at the firm level, to achieve supply-chain sustainability.

Differentiating the closed-loop supply chain from reverse logistics is difficult because of the lack of any comprehensive study covering both the topics - however, Guide and Wassenhove (2009 p. 10) define closed-loop supply chain management as 'the design, control, and operation of a system to maximise value creation over the entire life cycle of a product with the dynamic recovery of value from different types and volumes of returns over time'. Govindan and Soleimani (2017) distinguish the closed-loop supply chain as involving both forward and backward flows of products, covering the entire life-cycle of the products, as opposed to reverse logistics. In other words, the closed-loop supply chain involves both the reverse as well as forward logistics.

Also, a closed-loop supply chain is fundamentally different from reverse logistics in terms of scope and opportunities for innovation, argue Govindan and Soleimani (2017).

Batista et al. (2018) argues that 'the closed-loop narrative remains insufficient. Because it does not address [the] wider post-production and stewardship operations […] focuses more on the flows of main products, and is a detriment for the by-products and useful waste flow.' For example, the supply chain operations supporting waste flows and by-products synergies linking organisations from diverse sectors. They have suggested a 'circular supply chain archetype' that integrates all the four pieces of literature found within the operations management domain.

Velis and Vrancken (2015 p. 774) raise concerns regarding closing the loop, arguing, '… the existing limitations in material properties and the manufacturing and reprocessing technologies constitute the main showstopper for achieving much greater levels of resource and value recovery – more effective reprocessing technologies will be necessary for recovering value and closing the material loops'. While Velis (2015p. 391) and Velis et al. (2015) have identified the need for an evidence-based transition, and questions the need for innovation just for the sake of innovation. He argues that Value in secondary resources is multifaceted and the facets are interdependent and complex, needing robust evaluation for it to become a reality.

The Ellen MacArthur Foundation mentions open loop only once in its EMF (2012) report, when mentioning the RICOH Comet Circle™. Ricoh is a Japanese global copier manufacturer. Its Comet Circle™ is about practising recycling and remanufacturing (Lovins et al., 2013 p. 163; Hopkinson et al., 2018 p. 76). Otherwise, there is no mention of 'open-loop' in its EMF (2013b) report. It mentions 'open-loop' in its EMF (2014) report, making a case for converting open loop into closed-loop or under global reverse networks[7] .

- ***The role of Design in a circular economy***

Design is central to the closed-loop supply chain as it directly influences how the construction of the entire product's value chain is managed (Bevilacqua et al., 2008). It is a dynamic process centred on innovation, involving reducing the environmental impacts throughout the life of the product. Design for environment (DfE) is 'the systematic consideration of design performance concerning the environment, health and safety objective over the full product and process life cycle' (Fiksel, 1996). DfE from an engineering perspective addresses product life-cycle concerns early in the design phase. DfE combines several design issues. For example, design for disassembly; recovery; recycling; disposal; regulatory compliance; human health and safety

[7]This raises curiosity to find out more about open loop, closed-loop and closing the loop from both sides in real-life business environments – addressed in Chapter 6.4.1.

impact; and hazardous material minimisation. Thus, DfE is similar to design for manufacturing (DfM), design for assembly (DfA), and the design for production (DfP) (Fitzgerald et al., 2007 p. 2). Therefore, design plays a crucial role in supporting closed-loop supply chains and shared ownership models for sustainability. It, in turn, compels businesses to change their business models for product remanufacturing (Nasr and Thurston, 2006). As a result, closing the loop on material processes is one product development strategy. The starting point is the life-cycle analysis (LCA), which helps to analyse the entire product's supply-chain in order to understand the environmental impact at each stage in the production chain.

Table 2-1: Ten golden rules supporting Eco-design. Source: (Luttropp and Lagerstedt, 2006 p. 1401)

Ten Golden Rules	
ONE	Do not use toxic substances and utilise closed loops for important toxic ones.
TWO	Minimise energy and resources consumption in the production phase and transport through improved housekeeping
THREE	Use structural features and high-quality materials to minimise weight…in products…if such choices do not interfere with necessary flexibility, impact and strength or other functional priorities.
FOUR	Minimise energy and resources consumption in the usage phase, especially for products with the most significant aspects in the usage phase.
FIVE	Promote repair and upgrading, especially for system-dependent products (e.g. cell phones, computers, and CD players
SIX	Promote long life, especially for products with significant environmental impacts outside the usage phase.
SEVEN	Invest in better materials, surface treatments, or structural arrangements to protect products from dirt, corrosion, and wear, thereby ensuring reduced maintenance and longer product life.
EIGHT	Pre-arrange upgrading, repair, recycling trough access ability, labelling, modules, breaking points, and manuals.
NINE	Promote upgrading, repair, recycling by using few, simple recycled, not blended materials, and no alloys.
TEN	Use as few joining elements as possible such as screws, adhesives, welding, snap fits and, geometric locking according to the life cycle scenario.

The critical point of LCA in the product development process is in addressing the expectations or needs of customers/ markets. At this point, whilst taking critical decisions, considerations regarding the choice and availability of material, and the material's recyclability and product attributes, including its functionalities, are made; at the same time, keeping the overall environmental impact of the product to a minimum. At this starting point, the ten golden rules (as in Table 2-1) act as a checklist for the designers to develop an eco-friendly product. These ten golden rules were followed by Bombardier and Volvo (Luttropp and Lagerstedt, 2006) while undertaking new product development to lessen the environmental impact. New product development (NPD) is a subset of dynamic capabilities, often rooted in routines. It is often debated by dynamic capabilities scholars whether or not NPD is an ordinary capability or a dynamic capability (Iansiti and Clark, 1994; Lenox and Ehrenfeld, 1997; Eisenhardt and Martin, 2000; Teece, 2014a). Chapter 3 discusses this point.

- ***Cradle-to-Cradle™***

Cradle-to-cradle is an analytical framework and a prescriptive certification programme for product design and its material composition. It applies life-cycle analysis (LCA) to designing products. Chemist Professor Michael Braungart and architect William McDonough jointly developed this framework. The principles of cradle-to-cradle are similar to the Hannover principles that McDonough developed alone, a year before the launch of 'Cradle-to-cradle: remaking the way we make things' (Braungart and McDonough, 2002).

According to Cradle-to-cradle™ thinking, there is no waste, and all materials involved in a product are nutrients. The proponents contend that product can either be composed of materials that can biodegrade completely and become 'food' for biological cycles, or, of technical materials (except for some toxic materials) that can stay in closed-loop industrial cycles where they can be continually circulated as a technical nutrient to be used in some other applications(Braungart and McDonough, 1998). It essentially means breaking down any mass-produced product(s) into biological and technical nutrients, and after that, using materials from the separated components. The aim is to get rid of all toxic and disposable materials. The non-toxic materials either biodegrade into Earth's natural order or are used in combination with other materials. Braungart et al. (2007) proposed an 'intelligent materials pool' or creation of material banks that promote collaboration between firms. So that they agree to share a universal supply of high-quality materials and its information as well as pooling purchasing power, one of the impacts of 'materials pooling' would be that current producers of raw materials no longer sell but lease materials to companies who give the consumer access to them through product-service systems (Braungart and McDonough, 2002; Ness and Xing, 2017). Cradle-to-cradle ™ expects designers to be proactive and educate themselves about materials and circular design.

Life cycle analysis (LCA), the very basis of the Cradle-to-Cradle™, has issues such as (a) LCA can give misleading results making inappropriate suggestion to correct the problem, (b) LCA outcomes cannot be scaled up to represent extensive (national or global) results in the future, and (c) LCA is an engineering approach that reduces social and economic issues into estimated parameters, making LCA very complex (Gutowski, 2018).

- ***Performance economy***

Stahel (2006) introduced the concept of product-service-life extension. The performance economy is a framework that is knowledge-based and separates wealth creation from resource throughput. Stahel (ibid) contends that, currently, the industrial economy has reached stagnating levels of wealth and growth. There is excessive consumption of resources, and waste levels are rising, including debt and unemployment. Therefore, transitioning to a performance economy, where the focus is on performance rather than on the sale of the product, would bring ‘increased wealth creation, more jobs and reduced resource (energy and materials) consumption’ (Stahel, 2006 p. 4). In essence, this framework again pursues decoupling and dematerialisation and still has a capitalist approach to growth. Although Stahel does not state it explicitly, it implies that focusing on performance would reduce toxicity to achieve sustainability. Strategically speaking, reducing toxicity can only happen if a resource’s characteristics are knowable (Penrose, 1959). Therefore, characteristics of the resource become an essential consideration for choosing the material for producing a product. However, it will not address the entropy issue from a thermodynamics perspective. Focusing on performance means the product should have a performance guarantee rather than sales warranty. It also serves the interests of the manufacturers, as they can own their resources for as long as possible, which, in turn, promotes preservation or recapture of materials and brings the basic 3Rs into action. ‘Services rendered by a product’ becomes the overriding imperative more than a feature of the product. For example, General Electric is slowly shifting to selling Lux instead of bulbs; or, alternatively, washing machine manufacturers selling washes per machine rather than a physical washing machine. Performance economy needs a change in business models, as customers are encouraged to pay for using the product rather than purchasing the product.

- ***Bio-mimicry or Bio-innovation***

Another initiative linked to the circular economy is Bio-mimicry. Schmitt (1969) introduced this concept, attempting to solve human problems through sustainable innovation, drawing insights from natural plants and biological systems. They endeavour to manufacture products by establishing processes in such a manner that it deliberately decreases environmental impact and ensures regeneration of resources (Benyus, 1998; Swiegers et al., 2012). This thinking has become part of the DfE (Design for the Environment) programme, as it gains inspiration by observing and learning from nature (Mora et al., 2011). Janine Benyus (1998) focuses on nine core concepts derived from the study of the natural world. These are (a) nature runs on sunlight, (b) nature uses only the energy it needs, (c) nature fits forms to function, (d) nature recycles everything, (e) nature rewards cooperation, (f) nature banks on diversity, (g) nature demands local expertise, (h) nature curbs excesses from within, and (i) nature taps the power of limits. All nine concepts align well with delinking economic growth from consumption, a vital endeavour of the circular economy from the ‘advantage principle’ perspective.

- ***Thermodynamics & economics***

The relevance of the laws of thermodynamics to ecological economics and sustainability is that it provides a natural science foundation for sustainable development. It also provides one of the most important theoretical and practical pillars for understanding the economic process identified by many scholars (Georgescu-Roegen, 1971; Prigogine, 1972; Georgescu-Roegen, 1975, 1977; Prigogine and Stengers, 1984; Gladwin et al., 1995; Eisenhardt and Martin, 2000; Sousa and Domingos, 2006)[8].

According to the first law of thermodynamics, energy and matter can neither created nor destroyed. The second law is the 'entropy law', which states that, energy can move in only one direction, i.e. from high to low. When energy moves from high to low, mechanical work happens. Energy is the capacity of a system to do mechanical work. Each time mechanical work is done, some useable energy transforms to unusable energy, and this unusable energy is entropy. An increase in entropy causes heat to increase, which is the reason for global warming, hence climate change - a very abstracted form of explanation for global warming and climate change!

Any economic activities such as production, distribution, and consumption typically involve a transformation of the natural raw material resources into value to humans. Such a transformation requires energy. 'Even the services sector requires energy to sustain those who provide the service' (Daly and Farley, 2004 p. 63). We know from the first law that energy and matter cannot be created or destroyed. Therefore, natural raw material resources reserves such as minerals and fossil fuels that exist are limited in stock and exhaustible. This law implies that exhaustion of natural raw material resources will lead to loss of their unique characteristics. As a result, it would prevent economic processes those are reliant upon natural raw material resource(s) and its characteristics. It has a strategic implication as well, because unique characteristics of the resource(s), and strategic factors markets (raw material resources markets) have an essential role in helping firms improve their performance heterogeneity in order to compete (Barney, 1986, 1997).

Secondly, the product(s)/ produce, from the natural raw material resources, continues to exist because the first law states that matter/ energy is not destroyable. As a result, the resources that have lost their unique characteristics appear in unwanted waste flows somewhere in the environment. Now this becomes a waste-management issue. To conserve resources, closing-the-

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[8] Eisenhardt and Martin (2000 p. 1113) have informed that improvisational processes require constant energy to keep them on track. Thus, signalling an increase in entropy when firms attempt to achieve competitive advantage in high-velocity business environments.

material-loop, and recycling is preferred. Firms, with the motive of maximising returns, recycle such resources when the value of the reclaimed materials exceeds the cost to capture and restore them. Whereas firms with ecological impact consciousness recycle to conserve resources. The difference between these two approaches is the value system employed. Thermodynamics presents ‘an alternative value system, which can bring new understanding and insights into the issues of recycling. It can account for the restoration and loss of resources in a rigorous way’ (Gutowski, 2008 p. 1).

Mayumi (2017) states that thermodynamics helps to capture the biophysical dimensions of energy, and material transformation in an economic system. It further helps in monitoring energy and material, which are integral to society’s progress. Thermodynamics provides a theoretical foundation and bio-geophysical basis that helps to conduct technology assessments for sustainability. It also provides a unifying framework for analysing economic systems and ecosystems in terms of energy and material transformation. It, in turn, helps us to understand the bio-geophysical impact of consumption.

However, the applications of thermodynamics laws for understand the economic process have severe limitations. Firstly, thermodynamics has many variables such as temperature, pressure, and entropy, which do not have a counterpart in economics. While thermodynamics is good for the descriptive scheme, or pre-analytic vision of economics (Baumgärtner, 2004), such an analogy is often misused. Secondly, qualitative changes dominate such economic processes due to innovation and novelty. Therefore, the economic process will never reach an equilibrium state, and no formal equation can describe the evolutionary nature of economics. Thirdly, the generic nature of thermodynamics limits the study of social and ecosystem metabolism. Fourthly, thermodynamics is unable to capture the associated political barriers, including monetary costs, and toxic impacts. Therefore, it is of limited use in economics (Mayumi, 2017 pp. 89-97).

- ***Green economics and the circular economy***

Conventional economic policies are always towards material growth, where consumption and production are glamorised. Ecological economics challenges such neoclassical economic theory by bridging the gap between ecology and economics. To this effect, ecological economics also forms the basis of green economics (Cato, 2009). However, green economics differs in terms of orientation as it does not draw concepts for valuation and measurements of economic growth from mainstream economics, as ecological economics does. The natural raw material resources are central in green economics. It suggests an entire change of perspectives and attitudes towards the use of the natural raw material resources

Green economics proposes a move away from a focus on economic growth towards steady-state economics. According to its proponents, this is the only way forward for long-term sustainable growth. In this respect, green economics considers the planetary frontiers of the Earth and considers the Earth as the scarcest resource. It leads us to conclude that the Earth needs using wisely, maximising its productivity at the same time as minimising the use of it. Accordingly, the focus should be on quality and not quantity. As a result, there is a need to consider how many people are using the scarcest resources and to understand their consumption levels. All of this, despite us knowing well about the regenerative capacity of the Earth and its non-renewable resources.

Green economics proposes that the rate of use of the non-renewable resources should not exceed the rate of substitution of renewable resources, and that waste generation needs minimising, including limiting pollution to Earth's carrying capacity. Using Boulding (1966) metaphor of 'the cowboy', green economics suggests that the use of resources should be that of a spaceman and not that of a cowboy. The cowboy thinks that the resources are infinite, hence uses it recklessly thinking there are vast areas to absorb the waste thus generated; whereas the spaceman is aware of the limits of the resources that his spaceship , a capsule, can hold. He is also familiar with the waste that the limited resources generate, and therefore uses the available resources judiciously in order for them to last long (Cato, 2009 pp. 11 & 12).

All ten different concepts and frameworks discussed above have been considered as the building blocks of the circular economy (Igor et al., 2016 pp. 4-10; see fig 2 in Bruel et al., 2018 p. 15). If these are building blocks, then 'what does a whole circular economy[9] look like?' would be the next logical question.

2.5 Identifying empirical traces of the circular economy in the waste hierarchy, zero-waste, and technological advancements

This study's endeavour continues to search for the concept(s) that best describes the circular economy. The next closest explanations that are in use helping to understand a circular economy are (a) the waste hierarchy, (b) the zero-waste narrative, and (c) new technologies (for example, Industry 4.0), that allow economising the use of the natural raw material resources and managing waste in the economy.

[9] The 'whole circular economy' is equivalent to 'the ideally real circular economy' referred to in Chapter 4

- ***Waste hierarchy, Zero-waste, and the Circular Economy***

Nilsen (2019) contends that long before the circular economy was treated as an answer to sustainability problems, the waste hierarchy had a similar task. That is, to protect the environment, conserve resources, and to minimise waste generation (Williams, 2015' p. 1). The waste hierarchy has its roots in the ecological economics (Boulding, 1966; Costanza et al., 1997; Lederer, 2009). It was Boulding (1966) and Georgescu-Roegen (1975) who initiated the idea of reducing material input into the economy, based on the laws of thermodynamics, and proposed reducing material output, suggesting recycling as a way forward. Thus, both authors laid the theoretical foundations for the waste hierarchy (Nilsen, 2019 p. 31). Several other authors contend that 'Gerhardus, Wilhelmus, Adrianus, Josephus ('Ad') 'Lansink' is the founder of 'the waste hierarchy' famously known as the 'Lansink ladder' (Watson, 2013).

The waste hierarchy recommends sequential steps for using raw materials resources, starting from (1) reducing the use of natural raw materials resources, and energy, while reducing the waste generated, (2) reuse, (3) recycling the used materials and energy, and (4) incinerate for heat recovery or otherwise use waste as landfills. The Steps 1-3 relate to thermodynamics and the planetary boundaries, because reducing the use of natural raw material resources is a requirement for environment protection.

The OECD and European Commission adopted the waste hierarchy as their waste policy, a part of their eco-efficiency and ecological protection initiatives during the 1970s (Hajer, 1995; OECD, 2018; Nilsen, 2019 p. 31). The 'waste hierarchy' is still present in the latest European Commission waste framework e.g., Directive-75/442/EEC (1975) and Directive-2008/98/EC (2008). In addition to this, the European Commission recently added zero-waste and closing the loop, endorsing the circular economy in all its current directives after 2012 (European Commission, 2014, 2015, 2015a, 2015b) These inclusions led scholars to look at the waste hierarchy's 3Rs, i.e. reduce, reuse, and recycle, and the circular economy more closely (Sihvonen and Ritola, 2015; Chertow and Park, 2016; Reike et al., 2018).

The prefix-'re', in the waste hierarchy drew significant attention from the circular economy scholars, resulting in the literature getting inundated with 'Re' imperatives. Reike et al. (2018) found thirty-eight 'Re-' words in various combinations while reviewing 69 peer-reviewed contributions on the circular economy.

The 'Re' is a Latin word, which means not only 'repetition', 'again' and 'back', but also 'afresh', and 'a new', explaining the essence of the circular economy argues Sihvonen and Ritola (2015); (Reike et al., 2018). The list of' words used within the circular economy discourse, in alphabetical order, is as follows. ‘re-assembly, recapture, reconditioning, recollect, recover, recreate, rectify, recycle, redesign, redistribute, reduce, re-envision, refit, refurbish, refuse, remarket, remanufacture, renovate, repair, replacement, reprocess, reproduce, repurpose, resale, resell, re-service, restoration, resynthesise, rethink, retrieve, retrofit, retrograde, return, reuse, reutilise, revenue, reverse and revitalise’ (Reike et al., 2018 p. 253). However, fundamental to all these ‘Re’ imperatives is yet the original ‘reduce, reuse and recycle’ of the waste hierarchy - Sihvonen and Ritola (2015).

Sihvonen and Ritola (2015 p. 640) complemented the 3R typology with an additional ‘Re’, to include ‘Recover’. It unambiguously aggregates definition for end-of-life strategies, and their relationships. Kirchherr et al. (2017) found 4R typology mentioned in the circular economy definitions before 2012. Sihvonen and Ritola (2015) have combined the waste hierarchy, EU directive and ‘ten golden rules’ (Luttropp and Lagerstedt, 2006) used for Eco-Design to come up with ‘ReX’ taxonomy. The ‘10Rs’ in ‘ReX’ taxonomy expands each ‘Re’ in the basic 3Rs waste hierarchy. José et al. (2017) presented 9Rs as part of the circular strategies almost similar to ‘10Rs’. Reike et al. (2018), in order to lessen the confusion concerning ‘Re’ imperatives, introduced a new term, ‘value retention option - VRO’. The VRO framework divides 9Rs into three loops (shortest, medium, and long).

The author juxtaposed[10] all the waste hierarchy extensions offered by the four authors, namely; (a) Directive-75/442/EEC (1975), (b) Kirchherr et al. (2017) and Sihvonen and Ritola (2015), (c) Reike et al. (2018), and (d) José et al. (2017), and has explained each ‘Re’, presented in Table 2-2 below.

An example of the mapping is as follows: The shortest loop in Table 2-2 below matches with ‘reduce’, the ‘first re’ of the waste hierarchy. Here, ‘reduce’ of the waste hierarchy is being expanded to include (a) refuse (R0), (b) reduce (R1), (c) resell/ reuse (R2), and (d) repair (R3). Such expansions are useful for (1) eco-designing both from consumer and producers’ perspectives. It talks about generating less waste by shifting consumers to a post-material lifestyle (Black and Cherrier, 2010; Allwood et al., 2011) helping them to reduce consumption. It complements Luttropp’s (2006) ‘ten golden rules’ in Table 2-1 above as a guide for eco-designing. (2) It is also about refusing the use of hazardous natural raw material resources, or those that consume high energy in production. It calls for finding a substitute for such natural raw material resources, for designing out waste (Bilitewski, 2012) rather than disposal of waste after it has been created (Francis, 2003 p. 121). (3) Den Hollander and Bakker (2012) and Den

[10] See Appendix 7

Hollander et al. (2017) , call for sharing products and modularisation for reducing and prolonging the use of natural raw material resources.

Van Ewijk and Stegemann (2016) found that the waste hierarchy does not distinguish between open-loop and closed-loop recycling. They conclude that the waste hierarchy in its current form is an insufficient tool for reducing waste or making resource policy. They think it is suitable for avoiding waste disposal by landfill alone, but inadequate for reducing consumption of natural raw material resources and its impact on the environment.

Similarly, Gharfalkar et al. (2015) conclude that the waste hierarchy does not inform if the top level of the hierarchy refers to (a) reduction in consumption of scarce natural raw materials resources or, (b) a reduction in generation of waste by reuse, recycling and incineration or, (c) a reduction in the negative impact on the environment (Gharfalkar et al., 2015). Thus, the waste hierarchy seems to be falling short in addressing environmental as well as economic dimensions.

Table 2-2: Expansion of waste hierarchy in the circular economy context. Source Author (2020)

Results of juxtaposing different studies on 'Re' imperatives in the circular economy literature					
	EU Waste Hierarchy (Directive - 75/442/EEC, 1975)	Kirchherr et al. (2017); Sihvonen and Ritola (2015)	Reike et al. (2018)	José et al. (2017)	**Details**
	3R Typology	**ReX Taxonomy: 4R Typology**	**Value Retention Options (VROs)**	**Circularity strategies**	
CIRCULAR ECONOMY	REDUCE	REDUCE	Shortest loops – Smart product use and manufacture	Refuse (R0)	Aims to generate less waste from consumers' and producers' perspective –e.g. post- material lifestyle. Alternatively, making product redundant, i.e. avoiding hazardous materials in production, and use of virgin raw materials resources – e.g. stopping the use of plastic bags and offering the same function with a radically different product, e.g. design products using substitute materials.
				Reduce (R1)	It is increasing raw material resources' efficiency by consuming less virgin raw material resources in the first place rather than eliminating waste once created.
				Resell/Reuse (R2)	This category overlaps with reuse. Two sides of the markets emerge. A consumer can also be the seller – the product owner can sell his product at its end of life or if he/ she is content with it provided there is still value left in the product. Also, applicable at the firm level.
				Repair (R3)	It is a heavily used term in different contexts. It overlaps with the ReX reuse category. Repair and maintenance of defective products/ components for using with its original function. Making it as good as new or recreating (signifying 'regeneration'). It also signifies two-side markets.
	REUSE	REUSE	Medium loops: Extend the lifespan of the product and its parts	Refurbish (R4)	Repair and refurbish often get confused. Refurbish requires more work than repair but less work than remanufacturing. Restore an old product and bring up to date – again it signifies recreation (regeneration).
				Remanufacture (R5)	Remanufacture applies to full structure of a multi-component product is disassembled, checked, cleaned and if necessary, replaced or repaired in an industrial process. Use of discarded components in a new product with the same function.
				Repurpose (R6)	It is about using the same products for different purposes. This term is linked to 'rethink' the application of products or its waste for different applications.
	RECYCLE	RECYCLE	Long loops: Useful applications of materials	Recycle materials (R7)	It is about recovery operations by which waste materials are reprocessed into products, materials or substances whether for original or other proposes. Recycling is the most practised. There is much confusion with this term because often it gets used as an umbrella term.
				Recover (R8)	It means several things – recovery of energy through incineration, extraction of elements from end-of-life composites. Also, linked to added value and metal recovery, including the collection of used products at the end-of-life. Features prominently in reverse logistics literature.
		RECOVER		Re-mine (R9)	Re-mine is about collecting parts or components that could be of value for remanufacturing / repairing / recycling from vast dumps of waste. Urban mining of metals has been considered part of the circular economy. Often, re-mine gets linked to 'scavenging' or 'cannibalization', where people make a living by collecting rubbish and then separating valuable items from it.

While such explications are more about asset utilisation, they do little to remove confusion in understanding the circular economy. However, such explications help from an eco-design perspective, as they give the eco-designers a framework of different 'Re's' that they can use while selecting raw material resources for designing product attributes as per customers' demand *for zero-waste and the circular economy*

The zero-waste circular economy is a narrative promoted by the European Commission (2014) linking zero-waste to the circular economy. Subsequently, the EC published a list of 27 raw material resources that are critical for Europe (European Commission, 2018 p. 5). They suggested 'near zero-waste' for electrical and electronics waste (WEEE) and electric vehicles (ELV). The European Commission also released an action plan for closing the loop (European Commission, 2015, 2015a, 2015b).

The Cradle-to-Cradle™, the closed-loop concepts, and the waste hierarchy (already discussed above) together form the basis of the zero-waste circular economy. The aspirations of industrial symbiosis also underpin the zero-waste circular economy.

The zero-waste circular economy version of the circular economy has come under criticism. (Velis and Vrancken, 2015); De Man and Friege (2016) contends 'the first problem is that, in reality, waste is rarely 'food''. This assertion negates Braungart and McDonough's (2009) Cradle-to-Cradle™ notion that waste is comparable to technical nutrients and food for another producer. Further, they conclude that the assumption that 'circular' solutions necessarily lead to sustainable outcomes is wrong (ibid p. 93). Further, they also argue that the circular economy is a feel-good story, ignoring the practical difficulties in waste collection and management.

The criticism of the zero-waste circular economy is that it is an ambitious model of technical flows, and for its claim that waste-is-resource. Corvellec (2018) argues that aiming for zero-waste is about taking a dissociative view of the waste, a kind of failure that in an optimally efficient world should not exist. This dissociative approach views waste as having negative or zero value. It is in contradistinction to the associative view of waste. Drawn from a scat analogy, it considers waste as an unavoidable condition of life, and an opportunity that needs exploration rather than making it disappear (Bennett, 2010; Joshua, 2014; Corvellec, 2018). Bermejo (2014) argue that in today's globalized markets where the value of the product chains is so complicated, companies cannot build close material loops. They also cannot aim at closing the loops from both ends. Valenzuela and Böhm (2017) argue that the zero-waste circular economy is essential, a rationale for capital accumulation. Gregson et al. (2015) contend that this is a wrong way of resource recovery, because it is being built upon the conjectured reality of a politically created markets, of material properties and driven by discourses on ecological modernization. That is, it means the reality of the zero-waste circular economy is something different from what it appears to be, i.e. similar to a moral economy

- ***Industry 4.0 and the circular economy***

Digitalisation and digitisation[11] are enablers of the circular economy (Antikainen et al., 2018). They are also central to Industry 4.0. The German researchers *Henning Kagermann, Wolf-Dieter Lukas, and Wolfgang Wahlster* conceptualised 'Industry 4.0' for maintaining the competitiveness of the German economy (Kagermann et al., 2011; Stock et al., 2018). The industry 4.0 is a combination of Cyber-physical systems (CPS), the Internet of Things (IoT), Big Data and Cognitive Computing.

Industry 4.0 is composed of Cyber-physical systems. These are primarily physical components involved in the production processes of a manufacturing unit that are fitted with sensors, and actuators, and have software embedded in them. As a result, these physical components can process and communicate data over the internet. All such physical components within a manufacturing system and its sub-system are in turn able to continuously communicate and network with each other in real-time. It helps the manufacturing system to perform predefined tasks and monitor and evaluate specific data in the system by using the sensors in real-time. Based on the evaluated data, they control physical processes using actuators. Several manufacturing systems, interconnected through networked physical components in real-time over the internet, constitute the Internet of Things (IoT) (Stock et al., 2018). The real-time operations require networked manufacturing systems to deal with a vast amount of data, creating problems for data storage and retrieval at any given point in time, thereby making the entire production processes cumbersome and complicated. Cloud computing offers flexible ways of allocating highly automated and specialized hubs that allows seamless storage and retrieval of such data sets. (Bauernhansl et al., 2014; Bauernhansl, 2016; Monostori et al., 2016).

Thus, Industry 4.0 can connect resources, services, and humans throughout the production process in real-time. It also enables collecting and exchanging real-time information to identify, locate, track, monitor and optimize the raw material resources in any production processes. Such factories are known as a 'smart factory', or a 'digital factory', or 'smart manufacturing'. This kind of manufacturing system is highly flexible, inter-operable and reconfigurable (Rojko, 2017

[11] Digitization deals with converting any information into digital format, where information is organized into discrete units of data called bits that can be separately addressed, usually in groups of bits called bytes. While digitalisation is about using digital technologies to change a business model and provide new revenue and value-producing opportunities. Following Antikainen et al. (2018), here digitalisation refers to new digital technologies that are currently transforming the manufacturing industry such as IoT, Cloud Computing, Artificial intelligence, machine learning, RFID, and many others.

pp. 77 & 81), to the extent that it is possible to manufacture product in batch size one (Stock et al., 2018 p.257).

When such transformative technologies, coupled with innovation, are leveraged for regional economic growth, it is known as smart specialisation (Foray et al., 2011; Foray and Goenaga, 2013; OECD, 2013b; Bachtler et al., 2019; Bailey et al., 2019a; D'Adda et al., 2019). 'Smart specialisation' captured the attention of the European policymakers very quickly. It is in a trial to implement the circular economy at a regional level, thereby connecting trans-regional operational networks for resource efficiency (Foray et al., 2009; European Commission, 2015, 2015b; Igor et al., 2016; European Commission, 2017c; UNESC, 2018).

Industry 4.0 has been considered an opportunity to realise the circular economy, because it allows managing in real-time the raw material resources, and its waste, more efficiently. It also helps to close-loop the supply chains. That is, it augments the proposed circular supply chain archetype, thereby helping in creating value (Batista et al., 2018 pp. 446 & 447).

Kagermann et al. (2011) contends that Industry 4.0 impacts the interrelationships of industrial value creation networks throughout the life cycle of a product. It means, right from acquisition of the raw materials resources to manufacturing, to the product's use, and services; up to the end of a product's life and beyond, all phases could be connected. Not only one product's life cycle, but different products' life cycles that a smart factory manufactures can be connected by an exchange or flows of materials. Similarly, there is a possibility of connecting a variety of different smart factories, thereby creating an industrial value creation network through different levels of aggregation. Such an aggregation would be economically feasible based upon the available manufacturing technology and opportunities for scaling up. These interconnections could also be across different functions throughout the life cycle of a product or a group of different products. For example, different phases starting with mining or 'acquisition of the raw material resources phase', 'product development phase', 'manufacturing', 'assembly', 'logistics', 'services', 'maintenance' during the use phase can be connected. Similar connection is possible during the end-of-life phase of a product, i.e., in 'reuse', 'remanufacturing' and 'recycling' phases (Jovane et al., 2017).

Industry 4.0, if integrated with ICT, shows great potentials for sustainable value creation across the social dimension (Stock et al., 2018 p. 265), which is absent in the current circular economy debates (Murray et al., 2017 p. 376). Raabe et al. (2017) and Low et al. (2018) have presented the architecture for a collaborative platform. It helps firms to simulate and analyse the economic viability of establishing waste-to-resource exchanges using the industrial value creation network[12]. They have designed this collaborative platform architecture to enable industrial symbiosis to overcome the non-technical barriers of the industrial symbiosis. However, their understanding is that the realisation of a circular economy could also be through industrial symbiosis.

For Kalmykova et al. (2018) and Wang and Ji (2018), the manufacturing using Cloud computing (also known as Cloud manufacturing) is a new type of Product-Service System. Big data is the key to sustainable competitive advantage. Product-Service Systems (PSS) are part of the servitization strategies (Kryvinska et al., 2014). We know from previous discussions above that the performance economy realised through servitization strategies (Stahel, 2006), that is through 'services rendered by the product'. Based on this, PSS becomes part of the performance economy. That means Cloud manufacturing helps to realise the performance economy, servitization strategies and PSS. It becomes a bit confusing and challenging to differentiate between these three approaches to decouple economic growth from the consumption of the raw material resources. Similarly, for Dilberoglu et al. (2017) 'additive manufacturing' or 3D manufacturing – a non-traditional manufacturing method, forms part of the smart factories, which is an integral component of Industry 4.0.

The boundaries seem to be blurring between a circular economy and other concepts discussed above. Each concept is about employing cutting-edge technology for extending the product's life, thereby maximising raw material resources productivity, or helping to decouple economic growth from the consumption of the raw material resources.

Thus far, all the models, the concepts discussed in sub-section 2.3; and the waste hierarchy, the zero-waste narrative and different frameworks discussed under new technologies in this sub-section 2.4; have given us some knowledge about the circular economy. However, this acquired knowledge of the circular economy is not definitive because the understanding of the circular economy is either through correspondence or through conceptual mediation. As a result, the next logical step towards understanding the circular economy is to study how different academics and practitioners have defined the circular economy.

[12] They have named it as the 'By-product Exchange Network (BEN) model'.

2.6 Studying definitions of the circular economy

Kirchherr et al. (2017) has documented and reviewed 114 definitions of the circular economy. These definitions demonstrate the prevailing confusion and support the author's claim made above about the absence of a definitive understanding of the circular economy. Korhonen et al. (2018b) contends that the circular economy concept is a collection of loose, fragmented ideas drawn from a variety of scientific disciplines, including emerging fields and semi-scientific concepts. The circular economy concept is unclear and confusing to comprehend'. Geissdoerfer et al. (2017) argues that the most popular definition of the circular economy employed to-date is from the Ellen MacArthur Foundation (EMF)-sponsored study conducted by McKinsey and Co, detailed below:

> *'The circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, with this, business models' EMF (2012 p. 7).*

The author considers this definition as a practitioner's definition because 'restorative' and 'regenerative' words are theoretically contentious; and therefore, require reconciliation. The Ellen MacArthur Foundation (2012 p.7) mentions '…restorative *or* regenerative by intention and design…' in their first report. Then '…restorative *and* regenerative by design…' in their subsequent report (EMF, 2015a p. 19). The **'and'/ 'or'** evidences a lack of depth and clarity in the minds of the definer(s) raising the question of whether 'restorative' and 'regenerative' are synonyms or if they are two separate words, each describing a different set of activities.

Morseletto (2020a) evaluates the use of 'restoration' and 'regeneration' words, within the circular economy literature. He informs us that academics, as well as non-academics, invariably use both words whenever they define the circular economy. Nevertheless, the words 'restoration' and 'regeneration' have never been distinctly defined or explained in the circular economy literature. However, many academics consider 'restoration' and 'regeneration' as the central tenets of the circular economy (e.g. Murray et al., 2017; Korhonen et al., 2018b; Reike et al., 2018). Additionally, most academics often quote this definition verbatim directly from the EMF sources, while others offer it with a few iterations (e.g. Geissdoerfer et al., 2017; Bressanelli et al., 2018; Heyes et al., 2018).

The terms 'restorative and regenerative' start with 'Re'. 'Re' is a Latin word, meaning repetition. 'Restoration' is again a Latin word. It comes from the root word *'restaurare'* (c.1300). It means to ‘repair, rebuild, renew’ from ‘re-back, again’; ‘to give back’; also, ‘to build up again’ or, to ‘repair’ from the old French word ‘restorer’. The word ‘regeneration’ is again Latin (c.1500), originating from the root word ‘*Re*’- *‘generare’*. Its meaning is to ‘create again’, ‘to give birth/ generate - a being born again’; ‘make-over’. The presence of these words in the definition reflects the ideas that flow into building the circular economy concept, e.g. restorative economy, or restorative environment. From a design perspective, most often ‘regenerative’ is used, e.g. regenerative building, regenerative agriculture, and Cradle-to-Cradle™. (see Jenkins and Zari, 2009; EMF, 2012, 2013b; Ghisellini et al., 2016; Brown et al., 2018; Geisendorf and Pietrulla, 2018; Mang and Reed, 2018).

In the context of a circular economy, restoration typically gets linked to the ‘restorative design’, e.g. a ‘restorative development’ is one that combines returning polluted, degraded, or damaged sites back to a state of acceptable health of the ecosystems, through human intervention. (Jenkins and Zari, 2009; Mang and Reed, 2018).

Whereas ‘regeneration’ has been used for describing the pure sciences, such as in ecology, biology and medicine, for example, the power of cells to regrow themselves as in morphogenesis, e.g. ‘regenerative cell therapy’, ‘regenerative agriculture’, ‘regenerative design’, and ‘regenerative economic development’ (see Mang and Reed, 2018).

- ***Restoration and regeneration in the circular economy literature***

Morseletto (2020a) traced ‘restoration’ to the works of ecologist and entrepreneur Paul Hawken (Hawken, 1993), and regeneration to the works of Pearce and Turner (1990). They proposed the transformation of ‘resources-products-pollution’ mode to ‘resources-products-regenerated resources’ system, and the regeneration paradigm Cradle-to-Cradle™, which promotes eco-efficiency to eco-effectiveness (Lyle, 1994; Braungart and McDonough, 1998, 2002, 2009; Jawahir and Bradley, 2016 p. 104).

Paul Hawken advocates a restorative economy based on the conception of natural capital, which considers nature as a store of capital that needs maintaining and not plundering of its reserves of natural raw material resources. Therefore, the economy needs to be restorative, i.e. restoration occurs through the rebuilding of the natural capital (Hawken, 1993; Hawken et al., 1999; Cato, 2009). In the circular economy context, restoration is being used to restore natural capital (EMF, 2012, 2013b, 2014; Howard et al., 2018).

John T. Lyle (1994), an architect, calls for a regenerative design for sustainable development. His works saw the convergence of disciplines including architecture, landscape ecology, land-use planning, permaculture, and regenerative agriculture (see Rodale, 1983; Mang and Reed, 2018)

EMF (2012) refers to the 'technical cycle nutrients' and 'biological cycles nutrients'[13] to explain cascading in its self-promoted butterfly diagram (EMF, 2012 p.24; 2013b' p.29; 2014' p.14). Morseletto (2020a) demonstrates the presence of restoration and regeneration in both technical and biological nutrients cycles through the use of expanded 4Rs (Morseletto, 2020a pp. 4-9), presented in Table 2-2 above[14].

- *Tracking restoration and regeneration in technical nutrients cycles*

Morseletto (2020b p. 4) links reuse, repair, renewal, refurbishment, maintenance, and upgrading, to restoration, arguing that, except in re-use, in all other processes the products return to the economy after some kind of modification - hence, this entails restoration. However, there is an overlap in recycling, which is both restoration as well as regeneration. Restorative activities include use of discarded and second-hand materials or recovered parts and components, thereby extending the life of the product.

Recycling is regeneration, in the sense that it involves the transformation of waste into new useful material. For example, recycling of plastic (PET) bottles is chemically deconstructed to make new materials for use in manufacturing ink cartridges (Rahimi and García, 2017).

In the case of recycling, remanufacturing, and refurbishing activities, the use of regeneration is synonymous to restoration. However, regeneration is mostly attributed when recovery and recycling activities are in sequence. That is, recovering raw materials resources at the end-of-life and then through using recyclate so a new product is manufactured, e.g. aluminium or gold recovered from electronic equipment (Corvellec, 2018).

In the circular economy literature, 'regeneration', is also associated with the built environment, particularly, in relation to the building, spatial areas and cities (LWARB, 2017 p. 14; Domenech and Bahn-Walkowiak, 2019), urban regeneration (Jenkins and Zari, 2009; UNEP, 2017 p.140). Regeneration policy is about attracting inward investment in a region (Cato, 2009 p. 147).

Regeneration is also being linked to regenerating the raw material resources from products due to scarcity or price volatility of the raw materials resources (EMF, 2012; Lieder and Rashid, 2016; Geisendorf and Pietrulla, 2018).

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[13] These are a part of the Cradle-to-Cradle™ framework, explained in the previous section.

[14] The circular economy literature is witnessing infinite regress of 'reduce, reuse, recycle, and recover/ landfill' of the waste hierarchy – see Appendix 7 – *Juxtaposing ReX taxonomy and Value Retention Options*.

- *Tracking restoration and regeneration in biological nutrients cycle*

The restoration in the biological nutrients cycle is mainly to restore the natural capital. It follows from the Cradle-to-Cradle ™ explanation that biological nutrients that exist in industrialised systems decompose, thereby rejuvenating or restoring the soil in its original state. Restoring natural capital is also used in terms of 'reversing the damage' (Brown et al., 2018).

Regeneration has been used in regenerative organic agriculture by Rodale (1983) as an answer to create sufficient organic food for the growing population, while repairing the damaged ecosystem and addressing the climate change issue. Regenerative organic agriculture improves the resources it uses, rather than destroying or depleting them. It is a holistic systems approach to agriculture that encourages continual on-farm innovation for environmental, social, economic, and spiritual wellbeing (Rodale, 1983 p. 7).

However, regeneration and restoration are not easily distinguishable in the biological cycles (Morseletto, 2020a p. 6). For Rodale (1983), regenerative agriculture is essentially about minimizing the energy and materials and recycling water, nutrients, and organic matter (Pearson, 2007).

Morseletto (2020a p. 8) recommends not to consider 'regeneration', as a primary principle of the circular economy.

The author's view is that restoration and regeneration can happen only when there is sufficient value left in the unwanted (waste) materials of products and components to benefit the firm and in turn the overall economic system. Strategically speaking then, restoration and regeneration are directly dependent upon the productive services that the raw material resources offer to manufacture, or to remanufacture, products and components (Penrose, 1959). Furthermore, etymological discussions relating to the 'restorative-ness' and 'regenerative-ness' of the circular economy are of little significance, because what ultimately matters to business managers is the value gained, which could be through either restorative or regenerative processes.

Table 2-3: The circular economy definitions pre and post EMF (2012)

Definitions of the circular Economy in the literature				
Definition	**Author**	**Year**	**Influenced by**	**Country of origin**
'The circular economy, which is a mode of economic development based on the ecological circulation of natural materials, requires compliance with environmental laws and sound utilisation of natural resources to achieve economic development	(Zhijun and Nailing, 2007 p. 95)	2007	Ecology + Economic development	China
'…While the circular economy is not concretely defined, the central idea is to close material loops, reduce inputs, and reuse or recycle products and waste to achieve a higher quality of life through increased resource efficiency.'	(Peters et al., 2007 p. 5943)	2007	The waste hierarchy (WH)	China
'…the circular economy principle has been interpreted as a comprehensive state policy guideline and is seen as an integrated development strategy rather than an environmental strategy […] the need for an integrated approach that links upstream resources issues and downstream waste issues through the 3Rs concept or the circular economy/ society concept is attracting increasing attention…'	(Moriguchi, 2007 pp. 115-119)	2007	WH + Integrated development strategy	China
'a circular economy approach encourages the organisation of economic activities with feedback processes, which mimic natural ecosystems through a process of 'natural resources – transformation into manufactured products – by-products of manufacturing used as resources for other industries.' In essence, the circular economy approach is the same as the more familiar terms EID and 'industrial ecology'. It fits comfortably within a broad range of ecological modernisation initiatives pioneered around the world.'	(Geng and Doberstein, 2008 p. 232)	2008	Industrial Ecology	China
'CE was developed in China as a strategy for reducing its economy's demand for natural resources as well as ecological damage.'	(Sarkis and Zhu, 2008 p. 5)	2008	Ecology	China
The CE policy seeks to integrate economic growth with environmental sustainability, with one element relying on new practices and technological developments, similar to the application of environmental modernisation technology.'	(Park et al., 2010 p. 1496)	2010	Environmental sustainability	China
'Circular economy is essentially an ecological economy, which requires human economic activities in line with the 3R principle, namely Reduce, Reuse and Recycle.'	(Ying and Li-jun, 2012 p. 1683)	2012	The waste hierarchy	China
'The circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and with this business models.'	(EMF, 2012 p. 7)	2012	Ellen MacArthur Foundation & McKinsey & Co. (EMF)	UK
'The circular economy, then, is a diverse bundle of ideas which have collectively taken hold […] is located in the allied but distinct fields of ecological and environmental economics […] the circular economy seeks to stretch the economic life of goods and materials by retrieving them from post-production consumer phases. This approach too valorises closing loops but does so by imaging objects ends in their design and by seeing ends as beginnings for new objects. Unlike industrial symbiosis, the aim is to reuse or repurpose products later after their consumption.'	(Gregson et al., 2015 p. 3-5 & 9)	2015	EMF/Environmental economics/Closed-loops-C2C/Design thinking	UK

Table 2-3- 1: The circular economy definitions pre and post EMF (2012)

Definitions of the circular Economy in the literature				
Definition	**Author**	**Year**	**Influence by**	**Country of origin**
‘The circular economy (CE) is a simple but convincing strategy, which aims at reducing both inputs of virgin materials and output of waste by closing economic and ecological loops of resource flows.’	(Haas et al., 2015 p. 765)	2015	The waste hierarchy/Closed loop	Austria -Europe
The circular economy is defined by Charonis (2012), in line with Ellen MacArthur Foundation vision (2012), as a system that is designed to be restorative and regenerative. This author considers CE as an ‘alternative growth discourse’ and not an ‘alternative to growth discourse.’	(Ghisellini et al., 2016 p. 16)	2016	EMF	Italy/Sweden
‘The CE has been defined as an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models.’	(Hobson, 2016 p. 88)	2016	EMF	UK
‘We define the circular economy as a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. Second, we define sustainability as the balanced integration of economic performance, social inclusiveness, and environmental resilience, to the benefit of current and future generations.’	(Geissdoerfer et al., 2017 p. 766)	2017	EMF	UK/ The Netherlands (Europe)
‘A circular economy is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times. The concept […] is a continuous positive development cycle and preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows.’	(Moreau et al., 2017 p. 498)	2017	EMG	Switzerland (Europe)
‘A circular economy describes an economic system that is based on business models which replace the ‘end-of-life’ concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro-level (products, companies, consumers), meso level (eco-industrial parks) and macro-level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations.’	(Kirchherr et al., 2017 p. 224)	2017	EMF +IS + IE+WECD +WH	The Netherlands
‘CE is a sustainable development initiative with the objective of reducing the societal production-consumption systems’ linear material, and energy throughput flow by applying materials cycles, renewable and cascade-type energy flows to the linear system. CE prompts high-value materials cycles alongside more traditional recycling and develops systems approaches to the cooperation of producers, consumers and other societal actors in sustainable development work.’.	(Korhonen et al., 2018a p. 547)	2018	EMF+ WECD + WH +C2C	Sweden (Europe)
‘The concept can, in principle, be applied to all kinds of natural resources, including biotic and abiotic materials, water and land. Eco-design, repair, reuse, refurbishment, remanufacture, product sharing, waste prevention and waste recycling are all important in a circular economy.’	(Schroeder et al., 2019 pp. 78-79)	2019	EMF + C2C + WH + Eco-design	UK/ Germany

- ***Other trends identified in the circular economy definitions***

Allwood et al. (2011) and Bulkeley and Gregson (2009) report that 'the UK government has extensively promoted a waste hierarchy comprising of 'reduce, re-use, recycle' (DoETR, 1995), focussing more on promoting 'recycling'. In China, this is the 'circular economy'(Yuan et al., 2006). Ghisellini et al. (2016) and Kirchherr et al. (2017) findings are consistent with Bulkeley and Gregson (2009).

Currently, the circular economy discourse has moved away from the 4Rs of the waste hierarchy, claims Kirchherr et al. (2017). Contrary to this claim, the UK government, while recommending the circular economy in its 2017 industrial strategy (HM Government, 2017 p. 148), still prioritises waste reduction, through achieving a recycling rate of 50% (HM Government, 2020 p. 23).

Kirchherr et al. (2017 p. 227) report that only 12% of the 114 definitions reviewed include the notion of sustainable development. Geissdoerfer et al. (2017 p. 757) findings are consistent with this. However, the relationship between sustainability or sustainable development and the circular economy remains weak and ambiguous (Kirchherr et al., 2017). It signifies that sustainability and the circular economy discourses are not converging, as they should, considering that both work across the same three dimensions, i.e. economic, environmental, and social. A logical question arises - is there a deliberate attempt to separate sustainability from the circular economy discourse?

The emerging trends are:

(a) The end-of-life strategies are being replaced by the waste hierarchy framework

(b) The circular economy term is slowly taking over from sustainable development', thereby making the already existing confusion between sustainability and the circular economy more acute (Geissdoerfer et al., 2017 p. 757). This is because there are various interpretations of sustainability and sustainable development, and they are neither clear nor easy to implement, despite developing sustainability development goals (SDGs) (Nunes et al., 2016).

Kirchherr et al. (2017 p. 227), Murray et al. (2017) and Geissdoerfer et al. (2017 p. 765) found that the 'social-dimension' is omitted by the authors of the circular economy discourse, as only 13% of definitions refer to all three dimensions - environment, economic, and social equity (Brundtland, 1987; Elkington, 1998; WBCSD, 2017). This omission dims UNESC (2018 p. 2) expectations, as they anticipate achieving their SDG goals, i.e. (a) zero hunger (SDG 2), (b) reducing negative effects on human health (SDG 3), and (c) achieving universal access to affordable energy (SDG 7), through the circular economy framework.

Kirchherr et al. (2017) also found that economic prosperity has overtaken environmental and societal concerns. They contend that it is also a misnomer that business model innovations are an enabler of the circular economy. Similarly, future generations do not feature in the circular economy definitions, which is one of the core elements of sustainable development, reports Geissdoerfer et al. (2017). Only 1% of the circular economy definitions factor in such a time dimension (Kirchherr et al. (2017).

A sub-field of the circular economy, the sharing economy, is gaining momentum (Frenken and Schor, 2017; Schor, 2017), which is cohesive socially. The sharing economy is about sharing under-utilised resources, and there is an emergence of the collaborative commons of the 21st-century (Botsman and Rogers, 2010; Botsman, 2014; Bradley and Pargman, 2017).

Another absence identified in the circular economy discourse are the institutional dimensions to address the material and energy throughput into the economy. The circular economy literature does not discuss labour conditions, wealth distribution, and governance systems. There is a need for political reform that changes not only biophysical or economic rationality but also social rationality (Moreau et al., 2017 pp. 497 & 503). Studies of the circular economy from consumer perspectives are very few (Kirchherr et al., 2017 p.230). Additionally, the circular economy discusses lowering consumption. However, mainstream economics has yet to accept it as an economics framework, as a literature review by Camacho-Otero et al. (2018 p. 14) found new meanings of consumption in the context of a circular economy[15] .

Reviewing the circular economy definitions presented by Masi et al. (2018), Prieto-Sandoval et al. (2018) and Korhonen et al. (2018b), a few significant trends are noticeable, presented in Tables 2-2 and 2-3 above. In this sample, two sets of definitions emerge, the first one is a pre-EMF (2012) study, i.e. during the period 2007-2012, and the second, post this study between 2012 and 2019.

From Tables 2-3 and 2-3-1 above, we can see that most of the circular economy definitions offered from 2007 to 2012 originated in China. The definitions offered by Zhijun and Nailing (2007); Peters et al. (2007); Moriguchi (2007); Geng and Doberstein (2008); Sarkis and Zhu (2008); Park et al. (2010); and Ying and Li-jun (2012), are part of this first set. Initially, the focus of the circular economy was solely on economic development, giving due consideration to

[15] Consumption is developing as a meta-theory within circular economy narrative – see Appendix 8

environmental laws. Ecology, the waste hierarchy, and environmental sustainability influenced the definitions during this period.

The second set of circular economy definitions, articulated between 2012 and 2019, are mostly from the UK and European region. The definitions offered by EMF (2012, 2013b, 2014) and by academics such as Ma et al. (2014); Gregson et al. (2015); Haas et al. (2015); Ghisellini et al. (2016); Hobson (2016); Geissdoerfer et al. (2017); Moreau et al. (2017); Kirchherr et al. (2017); Korhonen et al. (2018b); Korhonen et al. (2018b); and Schroeder et al. (2019) are in the second set.

These set of definitions are significantly influenced by the EMF's (2012) definition. The EMF (2012) definition is considered seminal by Geissdoerfer et al. (2017) and Lieder and Rashid (2016). When we delve a bit further into the affiliations of these authors, we find that these author's institutions are current or ex-members of the CE100 club, and a part of the EMF's network of universities (EMF, 2015c).

The EMF's (2012, 2013b) definition has significantly impacted the nature of the circular economy discourse. Between 2012 and 2017, almost all definitions are similar or slightly abridged versions of the EMF definition. This finding is consistent with Kirchherr et al. (2017); Bressanelli et al. (2018); Geissdoerfer et al. (2017), and Heyes et al. (2018). The definitions offered in 2014/2015 are not as complex as those presented in 2017, 2018, and 2019. For example, most recent definitions of the circular economy, originating in the Netherlands and Sweden, are trying to move away from the stereotypical definition of the EMF. However, in so doing, they exhibit not only the influence of the EMF, but also the WECD (1987); the waste hierarchy; Cradle-to-Cradle™, eco-design, and the closed-loop concept; thus making the circular economy more difficult to understand.

The assertions from different sources about the influence of the EMF on the circular economy narrative, and EMF establishing the CE100 club and its network of universities, signifies Kuhn's (1962) paradigm community. Kuhn argues that 'truth' is achieved through discussion and rational consensus endorsed by influential people in society, which he has referred to as the 'paradigm community'.

According to Kuhn, it is the paradigm community that decides the nature of reality, its acceptance and rejection including the time of theory change (Dietze, 2001 p. 31; Easterby-Smith et al., 2012 p. 30). The EMF community's influence perfectly fits Kuhn's (ibid) description, which goes on to provide evidence that the Ellen MacArthur Foundation is promoting only a specific set of ideas about the circular economy, which suits it is funders (e.g. economic prosperity). Environmental protection, generational equity, social equity, institutional economics that includes labour contribution to production and consumption; all of these are either being phased out or neglected from the circular economy definition.

This new emergent tilt towards economic prosperity is in stark contrast to the literature review conducted by the author in 2015, when the circular economy was only to advance the sustainable development agenda (Brundtland, 1987); evidenced in Table 2-2.

Millar et al. (2019) identifies the absence of a circular economy definition that explicitly addresses sustainable development, and supports Kirchherr et al. (2017) that 'a distinction between ideal [real] and subverted definitions of the circular economy is needed' to understand the real powers of the circular economy.

Similarly, the paradigm community asserts that the McKinsey Global Institute coined the term 'circular economy'. Skene (2017) expresses his frustration at McKinsey's claim, saying 'more bizarrely, in a brazenly revisionist swoop, Baily et al. (2013) accredited the McKinsey Global Institute for coining the term' stating 'the circular economy is another term coined by the McKinsey Global Institute'. There is no evidence of this elsewhere in the literature'.

Kirchherr et al. (2017 p. 229) reports the most significant comment from one of the reviewers of his paper, he says, to quote: 'some of the authors […] seem to have no idea about what [CE] is about'. This statement correctly sums up the messy world of circular economy knowledge (Gregson et al., 2015 pp. 220 & 235; Pomponi and Moncaster, 2017 p. 713).

2.7 The epistemological issues within a circular economy discourse

Academicians and practitioners are trying to understand the circular economy based on their *a priori knowledge* gained from previous experiences. For example, thus far, from the above discussions, we know that the circular economy is about (a) resources conservation and elimination of use, (b) reduction and elimination of waste, (c) closed-loop cycles, (d) biological-technical nutrients, i.e. materials cycles and energy flows, and (e) design that is regenerative and restorative. These are circular models of production and consumption, pitched against the linear models, i.e. the extraction-production-consumption-disposal approach. The argument advanced is, circular is better than linear. However, this literature review also provides evidence that this argument is fallible as there are many controversies attached to it - the dominant being, the paradigm community is shaping/ orchestrating the conceptual knowledge of the circular economy.

This acquired knowledge of the circular economy is not definitive, because the understanding of the circular economy is achieved either through correspondence or mediated conceptually. We have already witnessed the disagreements regarding (a) the origins of the term 'circular economy', and (b) the conceptualisation of the 'circular model', itself. The study of antecedents and various concepts used for understanding the circular economy do little to clarify the various causal powers and mechanisms of the circular economy, thereby making the circular economy a victim of dissonant views, due to the over-enthusiasm of its proponents.

There is a conspicuous absence of a shared understanding of the circular economy. As a result of this absence, understanding of the circular economy has become messy both conceptually (for theory), and operationally (for practice). This absence is consistent with Kirchherr et al. (2017) as he also highlights the need for cumulative knowledge development of the circular economy.

The messiness in understanding the circular economy stems from the interplays of mechanisms, particularly how the paradigm community is influencing the circular economy narrative. That is, (a) distancing it from sustainable development, (b) absenting or muting the societal objective and intergenerational equity dimensions, (c) projecting it more as an economic prosperity model, and (c) distancing it from the waste hierarchy. Such manoeuvres can cause epistemological issues, elaborated below:

The paradigm community's abnegation of sustainable development from the circular economy discourse could stem from the 'greenwashing' caused by the buzz words 'sustainable development' (Robert et al., 2005 p. 20; Borland and Lindgreen, 2013 p. 182), which would make the circular economy 'business-as-usual' (Murray et al., 2017; Valenzuela and Böhm, 2017). As a result, the circular economy neglects the societal objectives and intergenerational equity dimensions. Such abrupt omissions and change of focus reduce the circular economy to just being a tool to implement sustainable development. For example, the comparison with a linear economy in order to prove the superiority of the circular economy, leaves sustainable development implementation through the application of the linear economy model of production, as ineffective, and perceived as a failure. However, in doing so, the circular economy places significant emphasis on waste. This argument scores above linear economy because it offers a resource-oriented solution, taking into consideration the inputs-outputs of a production process; but, in the process, it again becomes an implementation tool for realising sustainable development (Sauvé et al., 2016).

Another example is, that for some other experts, such as environmental economists' sustainable development is a concept that remains independent from its past unsuccessful initiatives, and particularly, independent of the linearity argument. In this instance, sustainable development is a societal objective defined at a macro level (ecological, economic, and developmental -societal sustainability). At the same time, the circular economy operates at a micro level, i.e. through the model of production and consumption. If successful, it again becomes a tool for sustainable development.

Such distancing of sustainable development also results in the need for grading the circular economy, as has been done in China, for implementing the circular economy ,i.e. implemented at three levels - macro, meso and macro (Yuan et al., 2006; Zhijun and Nailing, 2007; Geng and Doberstein, 2008). This type of conversation focusing on grading for implementing is absent in the western circular economy works of literature (Sauvé et al., 2016; Murray et al., 2017).

The circular economy paradigm community argues that the route to economic prosperity is achievable by following the circular way, i.e., following closed-loop cycles or cascading materials and energy flows as many times as possible at the end-of-life products - achievable through 3R or 4R processes. This argument has two fundamental issues, i.e. (a) closed-loop or cascading in any form is about physical flows of materials and not economic flows. There are no pieces of evidence of any such economic gains, except conjectures based on mathematical modelling, which is *Ex-ante* knowledge. Therefore, the notion that minimising the use of virgin materials and recycling would lessen the burden on the reserves of raw material resource, environment, and waste disposal is a misnomer. (b) Sustaining such virtuous close loops poses a practical problem because these loops eventually reach their limits. Recycling infinitely is not possible in the real world, without investing in recycling infrastructure. Also, whether the extra cost required for improving and refining further loops or circular materials flows would benefit society is a big question. Additionally, would the firm investing in such infrastructure be able to reap the returns, as the increased cost of refining would translate into increased production costs? In such circumstances, it is easier for firms to follow the short-cut route of business-as-usual and continue using virgin resources that turn out to be much cheaper and easier, with no financial risks to the firm (Andersen, 2006).

Lastly, though the paradigm community distances the circular economy discourse from the waste hierarchy, in reality, this literature review finds evidence that the circular economy model relies heavily on waste reduction, achieved through the 3Rs processes of the waste hierarchy (Sihvonen and Ritola, 2015; José et al., 2017; Kirchherr et al., 2017; Lazarevic and Valve, 2017). This distancing is evident from comparing all those different concepts used for understanding the circular economy, presented in Table 2-4 below.

Table 2-4: Comparison of concepts used to understand the circular economy. Source: Author (2020) inspiration from (Geisendorf and Pietrulla, 2018)

Comparison of Concepts used to Understand the Circular Economy

Categories	**Characteristics**	**Sustainable Development**	**Industrial Ecology**	**Industrial Symbiosis**	**Design-restorative/ regenerative**	**Cradle-to-Cradle**	**Closed-loop**	**Bio-mimicry**	**Thermo-dynamics & Economics**	**Closed-supply chains**	**Performance Economy**
Motivation(s) to follow	Focus on the environment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Including social aspects	✓				✓			✓		✓
Proposition for waste management	Efficiency and waste reduction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Zero-waste				✓	✓	✓				
	Technological/ biological nutrients cycles				✓	✓					
Guidelines and tools	Policy	✓	✓							✓	
	Business-model perspective					✓					
	Focus on operations	✓	✓	✓	✓	✓	✓		✓	✓	
	Measurability		✓			✓	✓			✓	

2.8 The research focus: Aim, Objectives, and the Research Questions

There are two domains of knowledge, i.e., ‘existing’ and ‘knowing’. It means we may ‘know’ or ‘may not know’ about the existence of an object[16]. However, irrespective of our ‘knowing’ or ‘not knowing’, the object exists. Thus, ontology deals with the ‘knowledge of the existence’ of the object (or domain of existence). Whereas epistemology deals with the ‘knowing of the object’ (or domain of knowledge), and accesses or operationalises ‘knowing the object’, through a variety of ways for example, through correspondence, previous lived experiences, related-ness or *a priori* knowledge (Bhaskar, 1978, 1979, 1993, 1998)

To put the above domains of knowledge in the context of the circular economy, the literature review demonstrates that all knowledge about the circular economy, thus far, is epistemological. That is, the understanding of the circular economy is either based upon *a priori* knowledge or achieved through correspondence. This epistemological knowledge of the circular economy, in turn, is being interpreted as the ‘real existence of the circular economy’, i.e. the ontology. That is, ‘the epistemological knowledge’ is understood as ‘the ontological knowledge’. In other words, we are reducing the ontological domain of existence to the epistemological domain of knowledge. It also means that the objective reality of the circular economy is knowable and describable, while accepting that all knowledge claims are fallible (Bhaskar, 1978; Collier, 1994; Spash, 2012; Mingers et al., 2013; Mingers, 2014; Spash, 2020).

Therefore, this research shall focus on gaining the ontological knowledge of the circular economy, which would give insights into its nature and composition. This focus will also help to explain reasons for the different mechanisms and interplays identified while carrying out this literature review. The author hopes[17] that an ontological knowledge would facilitate a uniform and shared understanding of the circular economy, because nature and composition are the very basis of the existence of any object, and they largely remain unchanged[18]. In turn, it would facilitate including the societal and intergenerational benefits in the circular economy discourses that are currently left out. A uniform and shared understanding of the circular economy would also help realise the conceptual aspirations of the circular economy, which is, to decouple economic growth from the use of natural raw material resources (UNEP, 2011; EMF, 2012, 2013a, 2014; UN, 2015; Ghisellini et al., 2016; Domenech and Bahn-Walkowiak, 2019).

[16] There are two types of objects of knowledge: transitive and intransitive. Transitive object includes theories, concepts, models, methods, or paradigms – distinction between them is available in Chapter 4

[17] The author has used the term ‘hope’ because knowledge is fallible.

[18] The nature and composition of an object will continue to remain unchanged, unless and until acted upon by an external stimulus Newton’s first law of motion holds true in the context of nature and composition of an object.(Huamao and Fengqi, 2007 pp. 95 and 95)

The economics of growth without using raw material resources, augmented by technological advancements such as Industry 4.0, while encapsulating societal and intergenerational equity dimensions, is an attractive proposition both for businesses and governments. Possibly, for this reason, Korhonen et al. (2018a) has referred to the circular economy as a contested concept. It demonstrates the ontological gap and evidence that academics are attempting to understand the circular economy through its epistemic knowledge.

Strategically, the circular economy concept becomes very important for firms as it can solve their problems of resource price volatility, resource acquisition, accumulation, and allocation. Probably because of such unexplored and unrealised powers of the circular economy, it has been considered as a resource efficiency strategy, or a developmental strategy (UNEP, 2006; Yuan et al., 2006; Geng and Doberstein, 2008; Lee et al., 2012; EMF, 2013a, b; Geissdoerfer et al., 2017).

These abilities of the unrealised powers of the circular economy to address multiple problems assign new meanings to it. As a result, it opens up an opportunity to treat the circular economy as a new paradigm within sustainable development discourse (Korhonen and Snäkin, 2005; Peters et al., 2007; Elia et al., 2017; Geissdoerfer et al., 2017; Urbinati et al., 2017).

The circular economy fits Kuhn's (1962 pp. 10, 11, 23, 53 & 59,) description of a paradigm, as he states, 'A paradigm is broader than theory or a gestalt that encapsulates a set of scientific assumptions and beliefs about a certain phenomenon. Paradigms gain their status because they are more successful than their competitors in solving a few problems that the group of practitioners has come to recognize as acute'. Kuhn (ibid) suggests that there are two stages of evolutionary development in any branch of science. That is, (a) pre-paradigmatic stage when there is no consensus on the conceptual treatment of the phenomenon, and (b) paradigmatic stage, which begins when a body of theory appears to have passed the canons of scientific acceptability. It is the dominant paradigm that signals scientific maturity, and the acceptance of agreed-upon standards, which Kuhn refers to as 'normal science' when research can proceed'.

Conceptually, the circular economy can solve the age-old tensions between the three dimensions, i.e., the economic, environmental, and societal that UN Sustainable Development Programme has not been able to thus far. However, let us consider both its conceptual ability and the non-agreement regarding its antecedents, conception, and even the coining of the term circular economy. All of these allow us to position a circular economy as a paradigm in its pre-paradigmatic stage.

Therefore, the above paragraphs can be summed up as; the circular economy is an amalgamation of different concepts to the extent that it is being referred to as a contested concept that is strategic and is, therefore, a paradigm – a claim that seems to be too good to be true, hence needing further investigation.

Therefore, **this research aims** to investigate the circular economy in UK manufacturing firms and the government agencies involved in formulating and implementing the circular economy centric policies. It means this research study shall investigate how the automotive and IT manufacturing firms and government agencies understand, construct, and operationalise the circular economy. It also assesses if the resource-based view's (RBV), VRIN framework is suitable for a firm participating in a circular economy.

The objectives that stem from the aim are to (a) explore the nature and characteristics of the circular economy, and (b) investigate how these impact the firm's use of resources for achieving competitive advantage, which, in turn, would inform policymaking.

The research questions that would help to address the aim and objectives are:

RQ1: What best describes the current understanding, construction, and operationalisation of the circular economy by UK manufacturing firms, and government agencies?

The significance of this research question stems from the literature review above, that evidences conflation and confusion in understanding the circular economy (Kirchherr et al., 2017; Murray et al., 2017; Geisendorf and Pietrulla, 2018; Korhonen et al., 2018b; Korhonen et al., 2018a; Mang and Reed, 2018).

Conceptually, the circular economy paradigm can solve the age-old prevailing tensions that exist for managing the three dimensions: economics, environment, and society, including intergenerational equity. Nevertheless, it is essential to know if this conceptualisation of the circular economy translates into practice. Investigating how firms understand and implement it would give insights about the nature and composition of the circular economy.

RQ2: How do firms manage waste?

The common denominator in various concepts discussed above (for protecting the environment and saving reserves of the natural raw material resources), is handling of waste effectively. Contrary to this, the paradigm community is distancing the circular economy narrative from waste or the waste hierarchy. Therefore, it will benefit if this investigation finds out how firms in reality manage their waste. That is, how they practice their understanding of the circular economy – i.e. Saying versus Doing.

These two research questions would help to address the first part of the set objectives, i.e. (a).

The second objective is about (b), studying the kinds of natural raw material resources firms require for achieving competitive advantage, as a result of their understanding of the circular economy.

In other words, what kind of raw material resources firms require *before and after* understanding the circular economy, to achieve competitive advantage.

Resources are central not only to a firm's existence but also in explaining the firm's position with its peers, including how one firm outperforms the other. Therefore, resources are of immense interest to strategic management scholars. Understanding the circular economy paradigm through resources and capabilities perspectives will not only inform us about how competitive advantage can be gained within circular economy environments, but also about its nature and composition. Therefore, there is a need to engage with strategic management literature to appreciate the role of resources in achieving competitive advantage, before studying its role in the context of the circular economy - presented in the next chapter, Chapter 3.

2.9 Conclusion

This literature review endeavoured to identify the more realistic theories/ concepts/ frameworks that best describe the circular economy. In so doing, this review finds evidence of the global footprint, and the various disagreements regarding the origin and conceptualisation of the circular economy.

In terms of identifying more realistic theories/ concepts/ frameworks from less realistic ones that best describe the circular economy, this review did not identify any theory; instead, most were either concepts or frameworks. That is, a realistic theory/ concept/ framework describing a circular economy is conspicuously absent.

The empirical traces in dealing with either one or all three dimensions (economic, environmental, and social), is found to exist as far back as the times of Plato in the 5th Century BC, to as recently as the 21st Century AD. All this means that, as a concept, the circular economy is not new. However, what is absent in the current discourses is morality, and belief in the virtuous actions for humanity's harmony with nature.

Ecology, and within it, ecological economics, emerged as the dominant discipline offering the more realistic explanation for the circular economy. The other concepts and frameworks, such as industrial ecology, industrial symbiosis, eco-industrial parks, closed-loop concept, Cradle-to-Cradle™, performance economy, biomimicry, design thinking, green economics, waste hierarchy, zero-waste circular economy, thermodynamics and economics, were found contesting with each other in addressing and balancing the three dimensions. While these concepts and frameworks have expanded the scope of the circular economy, which is promising, at the same time the understanding of the circular economy has become messy. The different causal mechanisms that are in –play, such as distancing the circular economy from waste hierarchy, muting the societal and intergeneration dimensions while amplifying the economic dimension, have further aggravated the confusion and conflation. It is reflected in the manner in which the circular economy is defined.

The noticeable absence of a shared understanding of the circular economy prompted this research to take an ontological perspective to find the realistic concepts/ frameworks that best describe the circular economy.

The economic prosperity achieved, based on decoupling economic growth from the consumption of raw material resources and recognising waste-as-resource, give reasons for this research study to find out how resources can help in achieving a competitive advantage. Therefore, the resources and capabilities literature review follow on from this chapter.

Chapter 3 A literature review of the resources and capabilities

3.1 Introduction

The purpose of this chapter is to explore strategic management theories, focusing on resources, to understand the role of resources in helping firms to achieve competitive advantage. Understanding different types of resources that help a firm to achieve competitive advantage will help not only in decoupling economic growth from the consumption of raw material resources but also to know the role of 'wastes', in achieving competitive advantage. It is so because wastes of raw materials resources underpin all concepts and frameworks currently used for understanding the circular economy concept. As an example, concepts/frameworks such as industrial symbiosis, eco-industrial parks (EIPs), closed-loop concept, cradle-to-cradle™, the role of design, all are fundamentally either about bringing back the end-of-life product (waste) for reuse, recycle, remanufacturing or about making the waste of one firm, a resource for another (e.g., Kalundborg ecosystem).

Within strategic management literature, there are three schools of thought which discuss competitive advantage as a concept, and there are two types of theories that explore how competitive advantage is achievable.

The first school of thought stems from the product-market approach and argues that competitive advantage stems from favourable terms of trade in the product-market (Porter, 1985). It believes that value creation happens when sales revenues exceed costs. However, there is no consensus on the concept of cost because it fails to ascertain the cost of the scarce resource(s). The second school of thought argues that 'super normal returns' reveal the advantage(s) a firm has over others. The problem with this is the calculation of the 'super normal returns' Typically, the internal rates of returns calculations are based on market-book ratios, such as returns on capital employed, or returns on assets, or market-book value. If these are normal returns then the basis of 'super' in 'normal returns' is not clear – is it relative to the expectations of the owners, or, intra-industry comparison or, is the 'super' concerning the economy? The third school of thought links competitive advantage to stock market performances. The problem with this conceptualisation is that the stock market works typically on market sentiments and is therefore very sensitive and reactive. So how to ascertain the stock performance gains achieved by a firm is *not based on* market sentiments (Rumelt, 2003). Different strategic management scholars have defined competitive advantage differently, presented in Table 3-1. Rumelt (2003) says there are four areas of confusion/ disagreement regarding competitive advantage. These are (a) how value is conceptualised and measured, (b) the meaning of rents, (c) confusion about the appropriate use of the opportunity cost concept, and (d) confusion or disagreement about whether CA means winning a game or having enough distinctive resources to maintain a position in the game. He identifies that the problem is not with the idea of advantage but with the concept of ‘cost and profit’, and in neo-classical economics profit is a chimera.

Table 3-1: Different conceptualisations of competitive advantage. Source: (Rumelt, 2003)

Author	A conceptualisation of competitive advantage (CA)
Porter (1985)	CA is about having a low cost, differentiation advantage, and strategic focus. He argues that competitive advantage stems from the value a firm can create for its buyers that exceeds the firm's cost of creating it.
Barney (1997)	'A firm achieves competitive advantage when its action can create economic value and when few competing firms are engaging in similar action'. Barney went on to link CA to performance, arguing that, 'a firm obtains above-normal performance when it generates greater-than-expected value from the resource it employs'. For example, the owner of a resource expects the firm to create value equivalent to £10.00 from deploying the resource. However, the firm creates value worth £12.00 – this positive difference between expected and realised value called the economic rent or economic profit. However, this economic rent depends upon the expectation, which is subjective.
Peteraf (1993)	Defines CA as 'sustained above-normal returns' achieved through imperfectly mobile resources, which ensures that Ricardian rents or monopoly rents arising out of it will not be offset entirely by accounting for the asset's opportunity cost (i.e. value to others).
Hunt and Morgan (1996)	Echoes Barney (1986) when they say CA is not attainable from freely tradeable assets. They either contend that the opportunity cost of those tradeable assets needs accounting so that it helps in creating a privileged market position or protected by deploying scarce assets. If the assets bought in factor markets were to be implemented a strategy, then the market price of those assets would be used to calculate the opportunity cost of deploying such assets in product-markets. However, deployments of such assets do not guarantee competitive advantage just because they are freely tradeable.
Saloner et al. (2001)	They argue that most forms of CA mean a firm's product and service is valued more by a customer than its competitors, or the firm is producing a product or service at a lower price than its competitors.
Kay (1993)	Distinctive capabilities become a competitive advantage when either it is brought to a market or applied to industry. Distinctive capabilities are the ones that others lack and are sustainable and appropriable.
Christensen (2001)	'Every CA is predicated upon a particular set of conditions that exist at a particular point in time for particular reasons. Many of history's seemingly unassailable advantages have proved transitory because the underlying factors changed'.
Ghemawat and Rivkin (1989)	CA is durable, superior financial performance.
Besanko et al. (2000)	Considers CA to be firm, earning a higher rate of economic profit from its competitors. Economic profit is 'the difference between the profits obtained by investing resources in a particular activity and the profits obtainable by investing the same resources in the most lucrative alternative activity.'
Brandenburger and Nalebuff (1996); Brandenburger and Stuart (1996)	Consider CA as decisive value-added, which is different from competitors in multi-agent games (industries). Agents include buyers, suppliers, and producers. Total gains to trade are the maximum available from the assignments among agents. They conclud that the maximum value appropriated as being limited by the agent's value added to the game - the amount the agent's presence increases the game's total value. Also, 'To have a positive added value it must be 'different' from its competitors ….. enjoying a favourable asymmetry.'
Pitelis (2009)	They have put forward the case for a 'quasi-sustainable competitive advantage'. The authors argue that firms exist to capture value (profit) from their value-creating activities. Firms can do this because of their ability to combine and manage co-specialized assets, develop appropriability mechanisms and, if necessary, create new markets.
McGrath (2013b) and Gupta et al. (2018)	They have put forward the case for a transient competitive advantage.

The two types of theories that discuss how competitive advantage is achievable are (a) competence-based theories (CBTs), and (b) governance-based theories (GBTs).

The competence-based theories consider that a firm's resources play an essential role in achieving a durable competitive advantage[19]. The CBTs are comprised of the resource-based view (RBV), the dynamic capabilities (DC), and evolutionary economics. The GBTs focus mostly on governance aspects and are comprised of agency theory, transaction-cost economics, and property rights theory (Williamson, 1999). The GBTs may be useful when discussing the implementation of the circular economy, particularly while configuring open or closed-loops and for creating circular supply chains, as a number of authors (Stahel, 2006; Bocken et al., 2016; Batista et al., 2018; Li, 2018) have considered closed-loop analogous to saving raw material resources. Governance models are required when resources undergo changes in structures and physical locations, passing through different agencies without a change in resources ownership (e.g., in recycling resources change their structure and premises). GBTs are not useful for understanding the type of resources needed for achieving competitive advantage.

Accordingly, this chapter explores the competence-based theories focusing on the (a) static resources (RBV), and (b) dynamic resources (dynamic capabilities), because both are important for this research study. While the RBV helps us to understand the characteristics of resources that are required to achieve competitive advantage in the circular economy context, the dynamic capabilities framework helps in understanding the business environment in which a firm operates. Furthermore, it takes decisions to adapt to the emerging circular economy environments, enabled by highly advanced technologies, such as Industry4.0. This approach is consistent with Eisenhardt (1989a) suggestion of use a single management theory to isolate a paradigm/phenomenon to study. In so doing, this study advances the knowledge of the RBV as well as dynamic capabilities, testing their applicability in the circular economy business environment.

Therefore, this chapter has been laid out as follows. It starts with (a) exploring the resource-based view in sub-section 3.2, and then (b) explores dynamic capabilities literature in subsection 3.3, and its empirical studies in 3.3.1. It is followed by (c) putting the resource-based view and dynamic capabilities in the context of the circular economy, in 3.4. From this contextualisation a conceptual framework resulted for investigating the circular economy in the manufacturing sector shown in 3.5. The conceptual framework also led to developing Seven Steps for organising the collected data for analysis, presented in 3.6, followed by the conclusion in 3.7.

[19] The use of the words 'durable competitive advantage' used here is essentially to differentiate between sustainable development and sustainable competitive advantage.

3.2 The Resource-Based View (RBV)

The resource-based view was started by Wernerfelt (1984), and then Dierickx and Cool (1988) referred to it as a resource based perspective (RBP), and later on it was developed by Barney (1991, 1997); finally it became the resource based theory (RBT) in the last forty-one years. The RBT/ RBV is still relevant to use for this research study because (a) it is a mature theory that focuses on raw material resources, which is central to the circular economy, (b) being a mature theory, it needs testing for its applicability in new and emerging business environments, such as the circular economy business environments, and (c) being a mature theory, it needs revitalizing (Barney et al., 2011 pp. 1299, 1301, 1302, and 1312). Previous to Barney et al. (2011), Trott et al. (2009) suggested that more work needs doing to examine RBV in SMEs and that RBV needs refinement. Thus, RBV/ RBT not only helps us to understand the resources in the circular economy context, but also provides an avenue for this research study to make a theoretical contribution.

- ***Main concepts, assumptions, and theoretical propositions of the RBV***

The scholarly debates around the resource-based view (RBV) historically come from at least four theoretical sources: (1) Penrosian economics, (2) Ricardian economics, (3) the traditional study of distinctive competencies, and (4) the study of the anti-trust implications of economics.

Early strategic management scholars focused on product-market approach using structure-conduct-paradigm (SCP), conceptualised by Ian Chamberlin and Joan Robinson, developed by Joe S Bain (1951), and extensively used by Michel Porter (1980, 1985). The SCP posits that a firm's performance depends upon the conduct of buyers and sellers in any market. The conduct is the result of the structure of the market, which is determined by the numbers of buyer and sellers present in that market. The unit of analysis is the market or industry rather than a firm. This framework does not allow us to understand the reasons for inter-firm performance differentials (Rumelt, 1984; Schmalensee, 1985).

It led Wernerfelt (1984) to come up with the idea of the 'resources-factor market' for finding performance differentials between firms, which was refined by Barney (1986), and the resultant framework came to be known as the 'resource-based view of the firm'. Both Wernerfelt (ibid) and Barney's (ibid) works underpin Penrose's (1959) theory, which is about how resources influence the firm's growth, and how growth is constrained in the absence of adequate resources.

After Wernerfelt's (1984) work there was an explosion of interest, reflected in the diverse range of contributions from different scholars. These included scholars such as Rumelt (1984), Barney (1986, 1989a, b, 1997), Coyne (1986), Dierickx and Cool (1989), Amit and Schoemaker (1993), Collis (1994), and Helfat et al. (2003), to name just a few.

Each of these works has enriched the RBV discourse with a different perspective about resources. They often relate it to the relationship between the set of opportunities facing the firm, the strategic behaviour that should guide the managers, and the outcome in terms of competitive advantage - all of these contributions are evaluated in terms of its relevance to the study of a circular economy, presented under the RBV development in Tables 3-2 and 3-3 below.

Table 3-2: RBV development. Part-1. Source: (Barney et al., 2011 p. 1301)

The development of RBV		
Author(s)	**Main contributions**	**Relevance from the circular economy context**
Introduction Stage		
Penrose (1959)	Theorized about how a firm's resources influence its growth; in particular, inadequate resources constrain the growth of the firm.	It offers an encompassing definition of a resource. Includes wastes-as-resource. Provides a theoretical foundation to the circular economy.
Lippman and Rumelt (1982)	Explained the concepts of inimitability and casual ambiguity; these concepts became core elements of the resource-based view (RBV).	Strong concept but does not consider the environment or society directly. Offers potentials for tailoring it for the circular economy.
Wernerfelt (1984)	Emphasized the value of focusing on firms' resources rather than on their products; coined the term 'resource-based view'.	Does not talk of reducing consumption of resources.
Barney (1986)	Theorized about how organizational culture could be a source of sustained competitive advantage.	Gives us the idea that culture could be a source to reduce consumption.
Hunt and Morgan (1996)	Developed the notion that resources are especially useful when no adequate substitutes are available	Requires assessing in the context of a circular economy.
Barney (1991)	Presented and developed the core tenets of RBV; presented a detailed definition of resources; and articulated the full set of VRIN characteristics that make a resource a potential source of competitive advantage.	Requires assessing in the context of a circular economy.
Harrison et al. (1991)	Highlighted the value of resources and synergy between resources in the context of diversification.	Relevant in the context of 4Rs processes.
Castanias and Helfat (1991)	Characterized CEOs as firm resources that possess varying (idiosyncratic) qualities and quantities of general, industry-specific, and firm-specific skills.	Role of managers - capabilities as resources.
Fiol (1991)	Organizational identity proposed as a core competency leading to competitive advantage.	Reiterates the use of culture as a tool to create an identity.
Conner (1991)	Juxtaposed the RBV with industrial organization economics in order to demonstrate that RBV was evolving as a new theory of the firm.	Provides a foundation to develop a theory of circular economy.
Growth stage		
Mahoney and Pandian (1992)	Further delineated the RBV by relating it to distinctive competencies, organizational economics, and theory on industrial organization.	Provides a foundation to develop a theory of circular economy.
Kogut and Zander (1992)	Introduced the concept of combinative capabilities; emphasized the importance of knowledge as a resource.	Provides a foundation to understand 4R processes.
Amit and Schoemaker (1993)	Split the overall construct of resources into resources and capabilities.	Helps to understand how to improve raw material resources productivity.
Peteraf (1993)	Outlined the conditions under which competitive advantage exists.	Provides a foundation to develop a theory of circular economy.
Hart (1995)	Introduced and developed a conceptual spin-off from the RBV called the natural-resource-based view of the firm	Helps to identify gaps in the RBV discourse. Links RBV to a circular economy.
Grant (1996)	Articulated the knowledge-based view of the firm as a spin-off of RBV.	Helps in lateral thinking for considering a circular economy theory.
Miller and Shamsie (1996)	Tested the resources-performance link while measuring resources directly.	Provides empirical evidence for testing VRIN in the circular economy context.
Conner and Prahalad (1996)	Identified situations where the application of opportunism-based arguments and knowledge-based arguments may lead to opposite predictions regarding the organization of economic activity.	Provides the foundations for developing a circular economy theory

Table 3-2 1: RBV development. Part- 2. Source: (Barney et al., 2011 p. 1302)

The development of RBV- Contd...		
Author(s)	**Main contributions**	**Relevance from the circular economy context**
Oliver (1997, October)	Theorized about how RBV and institutional theory together can better explain sustained competitive advantage.	Provides a foundation for developing a circular economy theory.
Teece et al. (1997)	Built on RBV ideas to introduce the concept of dynamic capabilities; in particular, explained competitive advantage as arising from the confluence of assets, processes, and evolutionary paths.	Provides a framework for investigating the circular economy in UK manufacturing.
Maturity Stage		
Alvarez and Busenitz (2001)	Explained the contributions of RBV to entrepreneurship research and articulated further contributions that are possible.	Facilitates extension of RBV to explain improving resource productivity in the circular economy context.
Priem and Butler (2001a)	Debated the usefulness of RBV as a theory of strategy and organization.	Provides intellectual rigour, which is useful while developing a theory of growth within the circular economy.
Wright et al. (2001)	Explained the contributions of resource-based theory (RBT) to human resource management research and articulated further contributions that are possible.	Not directly relevant to this research study.
Barney et al. (2001)	Identified the impact of RBV on related subject areas.	Identifies the absence, hence opens up an opportunity to apply RBV in the circular economy discourse.
Makadok and Barney (2001)	Built theory about the information firms should emphasize as they attempt to purchase scarce resources.	Highlights the importance of information acquisition strategy. In turn, informs the development of a circular economy theory - future research.
Makadok (2001b)	Synthesized ideas on excess profits offered by RBV and theory on dynamic capabilities.	Informs this research that, in reality, rent-generating resources can be partially substitutable. Highlights that the VRIN framework is not practical.
Lippman and Rumelt (2003)	Initiated discussion of the micro-foundations of RBV by introducing a payments perspective.	Helps to differentiate and conceptualise rents from a circular economy perspective. Although not directly relevant for this research study.
Ireland et al. (2003)	Introduced strategic entrepreneurship as recognizing the resources required to exploit growth opportunities in order to create and sustain competitive advantage.	Not directly relevant to this study. However, it informs the importance of strategic entrepreneurship. In turn, it helps to develop strategic entrepreneurs in a circular economy.
Winter (2003)	Introduced and explained the concept of higher-order capabilities.	Helps to understand dynamic capabilities. Helps to think in a parallel manner for a circular economy.
Gavetti (2005)	Built a theory about the micro-foundations of dynamic capabilities by emphasizing the roles of cognition and hierarchy.	It informs about Cognition as a capability. An important point for this research study.
Foss and Foss (2005)	Built conceptual bridges between RBT and property rights theory.	Provides a foundation for configuring circular supply chains. Not directly relevant to this research study.
Teece (2007)	Specified the nature and micro-foundations of the capabilities necessary to sustain superior enterprise performance in an open economy with rapid innovation and globally dispersed sources of invention, innovation, and manufacturing capability.	Brings together the capacity of a resource to offer productive services and a manager's capability to sense and seize productive services. Relevant to this research study.
Sirmon et al. (2007)	Built a theory about the underexplored processes, i.e., the 'black box', that lie between resources on the one hand and superior profitability on the other.	Provides a model for capturing value. \brings together the management of resources and processes, and provides useful background information for this study.
Armstrong and Shimizu (2007)	Reviewed and critiqued the research methods used in the resource-based inquiry	Informs of difficulty in testing 'Inimitability' in VRIN. Useful for this research study regarding the importance of clarifying boundary conditions.
Kraaijenbrink et al. (2010, January)	Considered the merits of prominent critiques of RBT.	It rightly identifies the limitation of the RBV, i.e. it narrowly clings to neo-classical economic rationality. It opens up the possibilities of seeing the RBV from a circular economy perspective.

The utility of RBV contributions in the context of the circular economy aspiration to decouple economic growth from resources use is present under the 'relevance' column in Tables 3-2 and 3-2-1 above. Identifying the relevance of RBV is consistent with the view that twentieth-century industrial revolution took resources for granted so much that even the economists of that time did not recognise the scarcity of resources explicitly in their theories. For this reason, there is an absence of any discussion regarding improving resources productivity with the sole purpose of environmental protection and achieving intergenerational equity (Ghisellini et al., 2016). The RBV contributions also provide knowledge for developing the theory of circular economy growth, which is currently absent. Such a theory could help to provide a shared understanding of the circular economy.

In the RBV literature, a resource has been referred to by different names such as capability, strategic assets, organisational competence, competencies, and core competencies. Different scholars have contributed to the development of RBV presented in Tables 3-2 and 3-3 above. These tables evidence the different dimensions of a resource.

Out of the different definitions, Penrose's (1959) definition of a resource is the most encompassing. She defines a resource as '…the physical resources of a firm consist of tangible things such as plant, equipment, land and natural resources, raw materials, semi-finished good, waste products, by-products, and even unsold stocks of finished goods…the other resources such as human resources available to the firm…even highly paid staff…are considered as resources…' (1959 p. 24). Penrose's definition is very relevant for this research, as it includes natural raw material resources and waste, among others.

The unit of analysis in RBV is the resource, and it seeks to explain the extent to which a firm may be able to sustain a position of competitive advantage. It views the firms as a historically determined collection of assets or resources tied semi-permanently to the firm (Wernerfelt, 1984). The central tenets of the RBV are path dependence and firm heterogeneity (Lockett, 2005).

The RBV's message is that the firm's performance differs because of different resource(s) endowments, and that a firm can sustain a position of competitive advantage if it has the ownership of firm-specific resource(s) that have the following attributes. Barney (1991) based the attributes of the firm's resources on the assumption that these resources are heterogeneous and immobile, i.e. they must be a) Valuable in a way that it exploits opportunities and reduces or neutralizes threats in the firm's environment, b) Rare among a firm's current and potential competition. All valuable resources cannot be a source of competitive advantage because a resource can be of value if, and only if, that resource is *either scarce or unusually uncommon*. He asserts that only firms' whose precious bundles of resources are rare can attain a competitive advantage. How rare a resource should be in order for it to have the potential for generating competitive advantage is not explained by Barney (1991), c) Inimitable – the firm’s resource(s) can be inimitable for one, or a combination of three reasons: (1) the ability of a firm to obtain a resource is dependent upon unique historical conditions, (2) the link between resources possessed by a firm and a firm’s sustained competitive advantage is causally ambiguous or, (3) the resource(s) generating a firm’s advantage is causally complex. The resource must be d) Non-substitutable, i.e., there should not be any strategically equivalent substitute for that valuable and rare resource.

Rumelt (1991) enriched the RBV debate arguing that inimitability of the firm’s productive resources depends on the extent to which they are protected by an isolating mechanism. He developed a list of these isolating mechanisms that can enhance the resource’s inimitability.

Peteraf (1993) highlighted the importance of *ex-ante* and *ex post* limits to competition and resource heterogeneity, that generate Ricardian rents, including immobility of resources to enable the rents to be bound to the firm. Heterogeneity, as articulated by Barney (1991, 2001) resembles Penrosian heterogeneity. Penrose (1959) argues that heterogeneity occurs because even firms with similar resource(s) endowments can configure them in unique combinations that yield a variety of services.

RBV identifies two factors that limit ex-post competition. They are (a) imperfect imitability and (b) imperfect substitutability. Rumelt (1984) called them ‘isolating mechanisms’ as they help to protect individual firms from imitation, thereby protecting the firm’s rent streams. However, Posen and Martignoni (2018) found that imitation is not bad because, during the process of imitation, the imitators develop extra insight or learning that fills knowledge gaps that exists within a set of non-imitable practices. In so doing, the imitators come up with unique processes that increase inter-firm heterogeneity.

Lippman and Rumelt (1982) concept of ‘causal ambiguity’ prevents the would-be imitators from knowing what to imitate and how to do it, which could act as a deterrent. Posen and Martignoni (2018) study is consistent with the ‘causal ambiguity’, as they conclude that imitation causes the risks to increase due to limited observability of practices (such as secrecy and tacitness).

Barney (1986) introduces the concept of the strategic factor market. He argues that firms acquire or develop the resources they need to implement their product-market strategies. A competitive advantage is created if a firm earns economic rent - a Ricardian principle (1817), which is dependent upon picking resources, similar to the way a mutual fund manager outsmarts the stock market by picking stocks. Firms need to be more effective than their rivals at selecting resources that will generate economic rent for them. Barney (1986) concludes that firms are more likely to earn economic rents from resources that they already possess, rather than what they acquire from external sources because the resources already in possession were either developed or acquired in a previous strategic factor market. At that time, the purchase price of the resource was a function of the expected value of those resources in that strategic factor market.

Dierickx and Cool (1989) offer the concepts of time compression, asset mass efficiencies, and interconnectedness of asset stock - three unique perspectives to limit competition.

Thus, the core concepts of the RBV are for a resource(s) to be a source(s) of competitive advantage; they need to be simultaneously unique; and difficult to trade, duplicate and substitute. The first two conditions are necessary and sufficient conditions for achieving competitive advantage, while the latter are necessary and sufficient conditions for sustaining competitive advantage. However, knowing the required characteristics of resource(s) for achieving a competitive advantage is just the start of understanding the resource, contends Bowman and Veronique (2000). Amit and Schoemaker (1993) contend that the RBV is essentially a theory of rents based upon resource market imperfections.

Many scholars have critiqued the all-inclusiveness definitions of a resource in the RBV, thus making RBV (a) unworkable (Kraaijenbrink et al., 2010, January), and (b) making it difficult to establish its contextual and prescriptive boundaries (Priem and Butler, 2001a; Galbreath, 2005). Some have suggested a concrete definition of resource(s) for the RBV (Black and Boal, 1994). Barney (1997) presented a revised version of the VRIN framework by integrating inimitability (I) and non-substitutability (N) into one and calling it organisation (O). Therefore, the resultant framework is VRIO instead of VRIN.

Stuart Hart (1995) identified the absence of ‘natural resources’ in the RBV conceptualisation. Therefore, he came up with N-RBV. He argues that if ‘natural resources’ is recognised in the RBV, it will prompt the right behaviour and careful handling of natural resources. This right behaviour then will not only address the negative environmental impacts of the natural resources use, but also help firms in achieving competitive advantage. Hart (1995) suggested three strategies, namely, pollution prevention, product stewardship, and sustainable development, for environmental protection and gaining competitive advantage.

N-RBV resembles empirical traces of the waste hierarchy, closed-loop, and design thinking, because pollution prevention emerges as the strategic capability when a firm decides to minimize emissions, effluents and waste linked to continuous improvement in processes. That is, it resembles the ‘reduce’ in the 4Rs. Firms achieve pollution prevention either through disposing of effluents and emissions with the help of pollution control equipment or, effluents and emissions are reduced through material substitution, recycling, or process innovation (Frosch and Gallopoulos, 1989; Cairncross, 1993; Willig, 1994). Continuous improvement in the processes is linked to TQM, which is about reducing costs and improving efficiency and profitability (Ishikawa and Lu, 1985; Schmidheiny, 1992; Smart, 1992; Schroeder et al., 2002; Walker et al., 2015; Rukijkanpanich and Pasuk, 2018).

Product stewardship expands the scope of pollution prevention. It includes the entire value chain or 'life cycle' of the firm's product system - this includes LCA and resembles designing products for recycling, remanufacturing, repurposing taking care of the environment throughout the product's lifecycle, and at the end of life of the product (Keoleian and Menerey, 1993; Braungart et al., 2007). The third sustainable development is about producing in a way that can be maintained indefinitely into the future.

The N-RBV framework was neither able to generate enough traction within a practice, nor attracted significant scholastic interests, when it was introduced in 1995. Hart and Dowell (2011, September), examining the popularity of the NRBV between 1995-2011, found that out of the three strategies, only pollution prevention was applied, while the other two, product stewardship and sustainable development, were ignored. His observation was that most of the firms continue to focus on incremental strategies such as eco-efficiency, pollution prevention, and corporate social responsibility. Hart and Milstein (2003); Hart and Dowell (2011, September) also found that when clean technology and 'base-of-the-pyramid' BoP strategies were gathering momentum, the strategic management scholars still faced challenges to resolve environmental and social problems, despite reducing negative impacts associated with production operations.

Orsato (2006) argued for a distinction between product/ services and organisational processes. He conceptualised generic competitive environmental strategies by reconciling Porter's (1985) cost differentiation (positioning strategy derived from product-market approach) and the RBV. He argued that 'RBV does not constrain the choices available to the firms or, to the structure of the industry.' He argued that a firm's capabilities of acquiring and managing raw materials resources need reassessing, and deployment to formulate strategies for environmental innovation, which would help firms to achieve competitive advantage. He also argued for incorporating corporate environmental and social responsibility in the total quality management (TQM) framework, thus swapping TQM for TRM - Total Responsibility Management. TQM has also been used for reducing waste and considered as a means to achieve competitive advantage (Wang et al., 2006, March). The TQM framework is absent from the circular economy discourse.

Galpin and Hebard (2019 p. 165) inform us that a globally accepted term is absent. All the phrases such as ‘sustainability’, ‘corporate social responsibility’ (CSR), ‘corporate social performance’ (CSP), ‘Going-green’ and ‘triple bottom line’, are one and the same - all of these refer to the firms enhancing their long term economic, social and environmental performance. Most of the works of literature devoted to conceptualising corporate environmental strategies argue that economic benefits result from taking caring of the environment. These environmental and sustainability strategies tend to promote materiality while promoting environmental protection. However, we know little about the motives of the firms embracing environmental strategies or corporate sustainability, and how these strategies are operationalised (Bansal and Roth, 2000; Zollo et al., 2013; Deryckere and Gauthier, 2019).

None of the works of the leading proponents of RBV and NRBV, such as Wernerfelt (1984), Barney (1991) and Hart (1995), recognised ‘waste’ explicitly. Also, none consider ‘waste’ worthy enough to be considered as a resource although all such works stem from the seminal work of Penrose (1959). There is an absence of considering resources holistically in the RBV and NRBV frameworks.

Value in the VRIN framework has attracted the interest of many scholars and emerged as a meta-text within RBV. Value and inimitability are central because rarity can exist only if a resource is valuable and essential only if competitors cannot imitate it (Hoopes et al., 2003). This value, in economic terms, is about how firms can maximise their earnings and extend them for long periods.

In the context of the circular economy and sustainability, value has other dimensions as well, such as societal and environmental value accruing from business activities. Therefore, businesses need to generate societal value, environmental value, and customer value, in addition to economic value. A business can generate societal, environmental, and customer value based on its moral and ethical values, argues Harlow et al. (2013). However, economic value is common to mainstream economics, but differs in terms of priority and weightage for the circular economy and sustainability. Following on from the circular economy and sustainability frameworks, the expectations from the businesses are that they give priority to environmental and social value while pursuing economic value.

Different scholars have argued about the ‘value in the meta-text within RBV’, usually in respect to (a) whether ‘value’ is exogenous or endogenous to the RBV framework (e.g. Bowman and Veronique, 2000, 2001, 2007; Bowman and Toms, 2010) and (Makadok, 2001a, b; Makadok and Barney, 2001; Priem, 2001; Makadok and Coff, 2002) following from Barney’s(1986) conceptualisation of the strategic factors markets; (b) the difference between value creation and value capture, i.e. when is value created and captured (Teece, 1982; Peteraf, 1993; Best, 1999; Foss, 1999; Makadok; Priem and Butler, 2001a, 2001b; Kim and Mahoney, 2002; Pitelis, 2004a, 2004b), and (c) on the conjectured reality of value (Pitelis, 2005; Pitelis and Teece, 2009).

These debates led Priem (2007) to conceptualise 'value' from the consumers' perspective, known as 'customer benefit experience' (CBE). He based his definitions of value creation and capture on the value-price-cost (VPC) framework, where V = use-value; P = exchange value; and C = production cost of the seller; then consumer surplus = V (minus) P, and seller's profit = P (minus) C, (adapted from Tirole (1988) and Hoopes et al. (2003)). It means that value creation happens when a consumer is willing to pay more, either for (a) some novel benefit(s) that they perceive, (b) for something that they perceive as better products/ services, or (c) when they perceive that they will receive an earlier benefit at a lower unit cost. Thus, for a consumer, value creation means an increase in use-value or decrease in exchange value - each situation is consumer surplus. Additionally, Priem (ibid) defines value capture as 'appropriation and retention of payments made by consumers in expectation of future value from consumption'. Therefore, value capture happens when a firm receives (a) consumer payment by defeating a competitor's attempt to imitate, and (b) simultaneously retains such payments by denying the claims on them from upstream or downstream members of the same value system.

According to Pitelis (2009) the determinants that helps in creating value are: (a) 'virtual markets', (b) 'value chains', (c) Schumpeterian (1934) innovation, (d) 'inter-firm resources', and (e) 'strategic networks'. According to Lepak et al. (2007) other determinants are (a) invention and innovation, (b) management and entrepreneurship, (c) managerial capabilities and cognition, (d) knowledge creation, (e) learning and entrepreneurship, and (f) social networks, and strategic HRM.

Pitelis (2009) presents a conjecture reality of the 'value' based upon Penrose's (1959) entrepreneur. To start with, an entrepreneur (also called an economic agent) conjectures or thinks or imagines ('image in the mind of an entrepreneur' - a Penrosian (1959) term), that he/ she possesses the capability to create appropriable value for the end-user, and also capture that value (profit) for themselves. At this stage the entrepreneur has the choice to sell the capability or advantage in the market, or create a firm that allows them to build the product or services and sell them to the end-user at a price that the end-user is willing-to-pay. In this case, the entrepreneur can sell at a price that is satisfactory to themselves, so then, at this point, the imagined value of the entrepreneur is realised, and the imagined value becomes the real value. Now, the reality of value coexists with value creation and capture. This realisation of value would depend upon the degree of existence of complete and perfect current and future markets.

If the entrepreneur, i.e., the economic agent, creates an organization to sell the idea/ advantages, then that organization would also help to capture the value created by other members, such as suppliers, distributors, or even customers, who may also help co-create value by appreciating ('valuing') or improving and promoting the idea/ advantage. The other members also have the opportunity to create complementary products/ services to offer to the value-creating organization of the entrepreneur/ economic agent. The members could also co-operate with the entrepreneur's firm to create co-specialised assets and together they can co-create markets, values, and prices, to capture as much as of the market as possible (Teece, 1986; 2006, 2018b; Pitelis, 2009). Thus, causality runs from conjectured or imagined value creation to realised value directly, or through setting up an organization. In this sense, value creation and capture are co-created and co-determined, and we can also say, they co-evolve (Pitelis, 2009).

However, despite knowing the causal pathways of value capture and creation, it could still be a daunting task to navigate during uncertain times with little knowledge and rationality. Penrose's (1959) concept of 'relatively impregnable bases' and dynamic capabilities (Teece et al., 1997; Teece, 2007) offers firms to manage uncertainty and change, diversity and direction, equilibrium and growth (Loasby, 1998; Helfat et al., 2007).

From the above discussions we can conclude that:

a) There is no unanimous agreement on the conceptualisation of competitive advantage, as profit remain a chimera.

b) A resource should possess VRIN characteristics to facilitate the firm in achieving a competitive advantage.

c) The NRBV and other environmental strategies are an add-on, contributing to the end-of-life strategies.

d) 'Value' in the VRIN framework has a conjectured reality.

e) The competitive advantage rests upon a firm's ability to create and capture value.

f) There is an absence of discussion about the creation of environmental and societal value in the RBV theory.

g) Economic growth is not separate from the consumption of resources in the RBV theory.

h) A theory of the circular growth of the firm is absent.

Therefore, these conclusions lead this study to address the second research objective by asking the third research question:

RQ3: How does the understanding of the circular economy affect the characteristics of the resources required for achieving a competitive advantage within circular economy environments?

The significance of this research question stems from an intuition about the underlying potential powers of the circular economy, because of the above conclusions. The potential powers may exist, but currently they are neither understood, exercised, nor realised.

For example, the absence of a unanimous agreement in conceptualising competitive advantage opens up the possibility of conceptualising competitive advantage entirely differently, i.e. a competitive advantage not based upon economic gains alone. Eisenhardt and Martin (2000 p. 1113) have signalled that overall entropy increases because improvisational processes that the firms employ for achieving competitive advantage are dissipative requiring constant energy to keep them on track (Prigogine and Stengers, 1984). Therefore, the environmental strategies need not buttress the needs of firms for economic gains any longer. Instead, the reconceptualised competitive advantage makes it mandatory for firms to formulate strategies that deliver environmental and societal value as part of them achieving competitive advantage. Then there would be no need for firms to follow the government's regulatory and statutory compliance. In turn, it would abolish the regulatory role of the government of protecting the reserves of natural raw material resources, address climate change, and deal with other negative impacts of the production processes. The other impact is that it would change the characteristics required for achieving a competitive advantage. In such an eventuality, testing the current VRIN characteristics of resource in the context of a circular economy becomes mandatory.

The conjectured reality of value in the VRIN framework tells us that everything starts with the imagination in the mind of the entrepreneur. Suppose the entrepreneur starts imagining environmental and societal benefits and not economic benefits alone, as they usually do. Then, the environmental and societal value automatically gets embedded in the value creation and capture process, thus making the realisation of the environmental and societal value a reality. Such environmental and societal value will extend the strategic factor markets concept to recognise wastes-as-resources. Also, it will establish the circular economy as a paradigm that addresses the tensions across the three dimensions, viz. economic, environmental, and societal, which sustainable development is not able to address.

In order for a firm to decouple economic growth from resources use, both physical resources characteristics, as well as capabilities, are essential.

Amit and Schoemaker (1993) were the first to differentiate between resources and capabilities. They define capabilities as the capacity of the firm to deploy the 'resources', usually in combination with organisational processes, to achieve the desired objective. It is through capabilities that potential services that the resources possess are realised. For Amit and Schoemaker (1993), capabilities are tangible and intangible processes that are firm-specific and develop over time, through complex interactions between different resources that the firm owns. They say it is possible to interpret capabilities as an intermediate product of the firms that help in increasing the productivity of their resources. Examples of capabilities are the continuous process of innovation, manufacturing, flexibility, responsiveness to market trends, and short development cycles (Amit and Schoemaker, 1993 p. 53).

The RBV is not able to explain such managerial capabilities (Katkalo et al., 2010a), which led Priem and Butler (2001a) to label the RBV as static in nature, and Verona and Ravasi (2003 p. 578 footnote no. 1) to consider the RBV as an efficiency-led static framework. However, the firm's manager is Penrose's (1959 p. 76) protagonist, as she has categorised the managerial capabilities as a resource, which drives performance heterogeneity.

Teece and Pisano (1994) came up with the dynamic capabilities framework (henceforth DC) considered as an extension of RBV, and focus on those firm-specific capabilities, including developing new ones that Penrose (1959 p. 85) has identified as limiting factors for the firm's growth. Penrose talked about two types of resources when a firm is planning expansion. One is inherited resources, and the second is the experiences and knowledge of its managers. She mentions that there is a close relationship between various kinds of resources and experiences, and the knowledge of the managers because, to extract benefits from the unused productive services of a resource requires experience, knowledge and extractable capacity of resources, and it is a challenge for the firm to bring all three together. In turn, it could also help the firm to achieve significant performance heterogeneity.

Some scholars say that the dynamic capabilities framework has roots in Ricardian economics (see Castanias and Helfat, 1991; Winter, 1995; Peteraf and Barney, 2003), while other scholars argue that DC's roots are in Schumpeterian economics (Mahoney and Pandian, 1992; Makadok, 2001b, a). They argue that the DC framework 'enables firms to achieve competitive advantage by creating and capturing Schumpeterian rents.' This results from creative destruction driven by continuous innovation and is not based on picking resources from strategic factor markets, as described in RBV theory. RBV accumulates Ricardian rents, whereas dynamic capabilities obtain Schumpeterian rents (Barney, 1986; Teece and Pisano, 1994 p. 552; Amit and Zott, 2001 p. 497; Peteraf and Barney, 2003).

Teece and Pisano (1994 p. 538) confirm that the dynamic capabilities framework has theoretical foundations drawn from the works of Williamson (1975); Nelson and Winter (1982); Williamson

(1985); Schumpeter (1934); Penrose (1959), and Teece's earlier works. Augier and Teece (2009 p. 412) identify the other influencers on the DC framework, such as the Carnegie School's concepts of the 1950s and 60s; the evolutionary economics of Nelson and Winter (1982); the behavioural theory of the firm by Cyert and March (1963); the transaction cost theory of Williamson (1975), and organisational learning (Argyris and Schon, 1978).

Scholars such as Bowman and Veronique (2003), Eisenhardt and Martin (2000), Helfat and Peteraf (2003), and Makadok (2001b), still view the physical raw material resources as more critical, and resource picking skills valid and complementary to the DC framework.

Such corroborations by different scholars make both RBV and DC frameworks vital for this research study, as they provide a theoretical basis for the circular economy approach to decoupling economic growth from the consumption of resources. In this respect, Penrose's (1959) idea of building 'relative impregnable bases' for the long-term success of the firm is directly relevant. This is because it involves the redevelopment of the resources, competences, and building technology bases through continuous innovation, by creating new knowledge bases and internalising creative destruction. To quote Penrose, 'the Schumpeterian process of creative destruction has not destroyed the large firm; on the contrary, it has forced it to become more and more creative' (Penrose, 1959 p. 166). Thus, creative destruction opens up the possibility of achieving a competitive advantage by reducing the consumption of raw material resources.

3.3 The Dynamic Capabilities View (DCV)

In order for a firm to decouple economic growth from resources use both physical resources characteristics, as well as capabilities, are essential.

Amit and Schoemaker (1993) were the first to differentiate between resources and capabilities. They define capabilities as the capacity of the firm to deploy the 'resources', usually in combination with organisational processes, to achieve the desired objective. It is through capabilities that potential services that the resources possess are realised. For Amit and Schoemaker (1993), capabilities are tangible and intangible processes that are firm-specific and develop over time, through complex interactions between different resources that the firm owns. They say it is possible to interpret capabilities as an intermediate product of the firms that helps in increasing the productivity of their resources. Examples of capabilities are: the continuous process of innovation, manufacturing, flexibility, responsiveness to market trends, and short development cycles (1993 p. 53).

The RBV is not able to explain such managerial capabilities (Katkalo et al., 2010a), which led Priem and Butler (2001a) to label the RBV as static in nature, and Verona and Ravasi (2003 p. 578 footnote no. 1) to consider the RBV as an efficiency-led static framework. However, the firm's manager is Penrose's (1959 p. 76) protagonist, as she has categorised the managerial capabilities as a resource, which drives performance heterogeneity.

Teece and Pisano (1994) came up with the dynamic capabilities framework (henceforth DC), considered as an extension of RBV, and focus on those firm-specific capabilities, including developing new ones, that Penrose (1959 p. 85) has identified as limiting factors for a firm's growth. Penrose talked about two types of resources when a firm is planning expansion. One is inherited resources, and the second is the experiences and knowledge of its managers. She mentions that there is a close relationship between various kinds of resources and experiences and the knowledge of the managers, because extracting benefits from the unused productive services of a resource requires experience, knowledge, and the extractable capacity of resources, and it is a challenge for the firm to bring all three together. In turn, it could also help the firm to achieve significant performance heterogeneity.

Some scholars say that the dynamic capabilities framework has roots in Ricardian economics (see Castanias and Helfat, 1991; Winter, 1995; Peteraf and Barney, 2003), while others argue that DCs roots are in Schumpeterian economics (Mahoney and Pandian, 1992; Makadok, 2001a, b). They argue that the DC framework 'enables firms to achieve competitive advantage by creating and capturing Schumpeterian rents.' This results from creative destruction driven by continuous innovation, and is not based on picking resources from strategic factor markets, as described in RBV theory. RBV accumulates Ricardian rents, whereas dynamic capabilities obtain Schumpeterian rents (Barney, 1986; Teece and Pisano, 1994 p. 552; Amit and Zott, 2001 p. 497; Peteraf and Barney, 2003).

Teece and Pisano (1994 p. 538) confirm that the dynamic capabilities framework has theoretical foundations drawn from the works of Williamson (1975); Nelson and Winter (1982); Williamson (1985);Schumpeter (1934); Penrose (1959), and Teece's earlier works. Augier and Teece (2009 p. 412) identify the other influencers on the DC framework, such as the Carnegie School's concepts of the 1950s and 60s; the evolutionary economics of Nelson and Winter (1982); the behavioural theory of the firm by Cyert and March (1963); the transaction cost theory of Williamson (1975); and organisational learning (Argyris and Schon, 1978).

Scholars such as Eisenhardt and Martin (2000); Makadok (2001a b); Bowman and Veronique (2003); and Helfat and Peteraf (2003), still view the physical raw material resources as more critical, and resource picking-skills valid and complementary to the DC framework.

Such corroborations by different scholars make both RBV and DC frameworks vital for this research study, as they provide a theoretical basis for the circular economy approach to decoupling economic growth from the consumption of resources. In this respect, Penrose's (1959) idea of building 'relative impregnable bases' for the long-term success of the firm is directly relevant, because it involves the redevelopment of the resources, competences, and building technology bases through continuous innovation, by creating new knowledge bases and internalising creative destruction. To quote, Penrose 'the Schumpeterian process of creative destruction has not destroyed the large firm; on the contrary, it has forced it to become more and more creative' (Penrose, 1959 p. 166). Thus, creative destruction opens up the possibility of achieving a competitive advantage by reducing the consumption of raw material resources.

- ***Definitions of dynamic capabilities***

Different scholars have defined dynamic capabilities differently, which stimulated fruitful intellectual debates around a firm's capabilities and their role in achieving competitive advantage. These debates are mostly regarding (a) different conceptualisations and dimensions of the dynamic capabilities, (b) categorisation of capabilities, (c) the characteristics of the environments, where dynamic capabilities are most impactful, and (d) old and new models of competition including next-generation competition, leading to (e) different emerging market structures. Some key contrasting definitions, in terms of their relevance for this research study, are presented in Tables 3-4 and 3-5 shown below.

Table 3-3: Definition of dynamic capabilities. Source Adapted from (Barreto, 2010) and (Zahra et al., 2006)

Author(s)	Definition of the dynamic capabilities	Relevance for this study
Amit and Schoemaker (1993 p. 35)	They were first to differentiate between 'resources' and 'capabilities.' For them, resources are stocks of available factors possessed by a firm. Capacity refers to the ability to perform a task, function or activity in the least minimally accepted manner. Capabilities are the capacity of the firm to deploy resources, usually in combination with organisational processes.	Helps to distinguish between resources and capabilities. Useful for this study.
Stalk et al. (1992 p. 62)	Define capabilities as 'a set of business processes strategically understood'. They contend that 'every firm has business processes that deliver value'. Whosoever competes based on capabilities, 'identify their key business processes, manages them centrally, and invest in them heavily, are looking for long-term payback'.	Leads to the understanding that firm-specific processes deliver value and to identify them. Signature processes (Gratton and Ghoshal, 2005).
Lenox and Ehrenfeld (1997p. 189)	They define the capacity of a firm to address environmental concerns in product development as its environmental design capability. This capability allows a firm to respond routinely and effectively to changing environmental demands through the design of products and processes.	Helps to identify a firm's design capacity as a dynamic capability that can potentially generate Schumpeterian rents.
Winter (2003 p. 991)	Defines 'an organizational capability is a high-level routine (or a collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type'.	Breaks down a firm's processes into routines, and then identifies the unit of analysis. Difficult to implement for this study.
Helfat and Peteraf (2003p. 999)	Define capability as the ability of an organization to perform a set of coordinated tasks, utilising an organization's resources to achieve a particular outcome.	These are very helpful as it ties tangible, intangible and objectives together. Allows us to include non-economic objectives. Useful for this study.
Helfat et al. (2007p. 4)	Dynamic capabilities as 'the capacity of an organization to purposefully, create, extend and modify its resource base'.	
The first definition offered by the proponent David J Teece and his colleagues in 1994		
Teece and Pisano (1994p. 541)	'Dynamic capabilities are the subset of the competence and capabilities that allow the firm to create new products and processes and respond to changing circumstances.'	Provides the conceptual basis for achieving competitive advantage. Useful for this research study.
Three years later - Second definition offered by the proponent David J Teece and his colleagues in 1997		
Teece et al. (1997p. 561)	'Dynamic capabilities are the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments.'	
Ten years later - the third definition offered by David J Teece alone in 2007		
Teece (2007p. 1319)	'Dynamic capabilities can be disaggregated into the capacity to (a) sense and shape opportunities and threats, (b) to seize opportunities, and (c) to maintain competitiveness through enhancing, combining, protecting and when necessary, configuring the business enterprise's intangible and tangible assets'	

Table 3-4- 1: Definition of dynamic capabilities Contd... Source Adapted from (Barreto, 2010) and (Zahra et al., 2006)

Author(s)	Definition of the dynamic capabilities	Relevance for this study
Seven years later - the fourth definition offered by David J Teece alone in 2014		
Teece (2014bp. 334)	'Dynamic capabilities do not operate alone; they must be coupled with effective strategizing to bring about competitive advantage…organizational capabilities drive enterprise performance. The capabilities shape and are undergirded by VRIN resources…in short, the joint presence of strong dynamic capabilities, VRIN resources, and a good strategy are necessary and sufficient for long-run enterprise financial success.'	The inclusion of VRIN characteristics is beneficial for this study. Elaborated in the main text, it helps to conceptualise the research framework.
Five years later David J Teece develops 'A capability theory of the firm' in 2019		
Teece (2019ap. 9 & 10)	Teece (2019a) clubs all his previous definitions together and adds more. Dynamic capabilities have to be 'built', through a process of investment in discovery, knowledge generation, and learning. Dynamic capabilities also reside in the organization's values, culture, and collective ability to implement a new business model or other changes quickly. How a firm's resources are coordinated and managed is at least as essential to competitive success and survival as the identity of the resources themselves. Capabilities such as asset orchestration and market creation (or co-creation) are vital to profitable resource management (Pitelis and Teece, 2010b).	The capability theory of the firm is constructive considering the influence of industry 4.0 on the circular economy Useful for this study.
Eisenhardt and Martin (2000 p. 1107)	'Reconceptualised the dynamic capabilities definition as the 'firm's processes that use resources – specifically the processes to integrate, reconfigure, gain and release resources to match and even create market change. Dynamic capabilities thus, are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve and die'.	Provides constructive criticism, thereby allowing us to understand different types of capabilities and the equifinality nature of competitive advantage. Elaborated in the main text.
Zahra et al. (2006 p.91)	Dynamic capabilities are 'the abilities to reconfigure a firm's resources and routines in the manner envisioned and deemed appropriate by its principal decision-makers'.	Role of top management teams (TMTs) highlighted.
Griffith and Harvey (2001p.598)	'A global dynamic capability is the creation of difficult-to-imitate combinations of resources, including effective coordination of inter-organizational relationships, on a global basis that can provide a firm a competitive advantage.'	Highlights collaboration between firms.
Makadok (2001b p.389)	There are two distinct mechanisms for economic rents, resource picking and capability building.	Provides fruitful discussion to understand better dynamic capabilities.

We can see from Tables 3-4 and 3-4-1 that David J Teece, along with his colleagues, has offered four different versions of a dynamic capabilities' definition in a span of twenty years (1994-2014), before presenting 'a capability theory of the firm' in 2019.

Out of these four definitions, the definition presented in 1997 raised lots of question regarding the conceptualisation and the nature of dynamic capabilities. Therefore, we find Teece's 2007 definition is more refined, compared to that of 1997. However, the 2014 definition is much more refined as it separates dynamic capabilities, VRIN resources, and strategy, arguing that the joint presence of all these three is a necessary condition for achieving competitive advantage (Teece, 2014b p. 334). It means that how the firms manage their raw materials resources, as well as coordinate their intangible resources, are as crucial to the competitive success and survival of the firm as the characteristics of the raw material resources themselves.

Capabilities such as asset orchestration and market creation (and co-creation) are also vital to the resource's management, contends Pitelis and Teece (2010b). Dosi et al. (2000) argue that capabilities are skills of the firm at an organisational level, embedded in organizational routines. For Grant (1991), 'capabilities are identifiable and appraised using a standard functional classification of the firm's activities'. Treacy and Wiersema (1993 p. 84) define capabilities as one of the three value disciplines - operational excellence, product leadership or customer intimacy.

Winter (2003 p. 991) defines 'an organizational capability as a high-level routine (or a collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type'.

Helfat and Peteraf (2003 p. 999) define a dynamic capability as the ability of an organization to perform a set of coordinated tasks utilising an organization's resources to achieve a particular outcome.

Helfat et al. (2007 p. 4); (Helfat and Peteraf, 2009) define a dynamic capability as 'the capacity of an organization to purposefully, create, extend or modify its resource base'.

Capabilities have been further categorised differently by different scholars such as (a) first-order or ordinary capabilities. These are mostly a firm's ability to earn its bread and butter (Nelson and Winter, 1982). The ordinary capabilities have been referred to as first-order competencies or zero-order by Collis (1994 p. 151); as second-order or 'substantive' by Zahra et al. (2006 p. 921); (b) the second category of capabilities shares the common theme of dynamic improvement of the activities of the firm. Amit and Schoemaker (1993 p. 35) identify second-order capabilities as 'repeated processes or product innovations, manufacturing flexibility, responsiveness to market trends, and short development cycles'. Teece and Pisano (1994 p. 20) saw second-order capabilities as dynamic routines that 'govern the ability of an organization to learn, adapt, change and renew overtime'; Henderson and Cockburn (1994 p. 65) have a second category of capabilities as 'component competence' and third category of capability as 'architectural competence'. (c) The third category helps for integrating effectively and developing new second-order capabilities, as and when required. The third category of capability relates slightly to the second. However, it includes metaphysical strategic insights to extract intrinsic value from resources, or to develop strategies before competitors can do so.

Collis (1994) notes that Barney (1992) refers to such capabilities as an organisation's characteristics that enable firms to choose and implement strategies, arguing that such notions correspond to Schumpeterian 'entrepreneurial' function (Schumpeter, 1934), and Lippman and Rumelt (1982) idea of 'the production of new production functions'.

The dynamic capabilities field of scholarship has expanded, as evidenced by Barreto's , 2010) and Schilke's , 2018) review of dynamic capabilities literatures. The latter's review captures the addressing of criticisms on multiple fronts. Accordingly, the dynamic capabilities literature covers areas such as:

a. Definitions of the DC construct

b. Theoretical assumptions underlying DCs

c. Theoretical integration of DCs with other theoretical lenses

d. Dimensions according to which DCs are characterized

e. Antecedents to the creation and use of DCs consequences (outcomes) of the utilization of DCs

f. Mechanisms (mediators) through which DCs influence outcomes. Many scholars view DCs, not as a unitary concept, but that DCs manifest themselves in many different distinct forms (Eisenhardt and Martin, 2000; Helfat et al., 2007; Helfat and Winter, 2011).

The dimensions of dynamic capabilities that have emerged as a result of addressing criticisms are:

1. ***Procedural****:* i.e. the types of processes that DCs are engaged in, e.g. coordinating/ learning/ reconfiguring (Teece et al., 1997), and sensing/ seizing/ transforming (Teece, 2007).
2. ***Routinization****:* The degree of the routinization of DCs, e.g. contrasting relatively spontaneous problem-solving with highly patterned routines (Winter, 2003).
3. ***Functional:*** the functional domain in which DCs are applied, e.g. alliances, product development, mergers and acquisitions (Eisenhardt and Martin, 2000).
4. ***Hierarchical*****:** the hierarchy of capabilities, e.g. zero, first, second, and higher-order capabilities (Collis, 1994).
5. ***Unit of analysis****:* the focal unit of analysis (individual, team, organizational, and extra-organizational - Adner and Helfat (2003); Felin et al. (2012)- (Schilke et al., 2018 pp. 395 & 401).

From the above discussions, the definitions offered by Helfat et al. (2007) and Teece (2014b), the procedural, routinization, and functional dimensions; and debates between Eisenhardt and Martin (2000) and Teece (2014a), are relevant for this research study, and these are elaborated in the paragraphs below.

From reviewing the circular economy literature, we know that it is considered as a resource efficiency strategy and/ or a development strategy that raises resources productivity, mentioned in government reports and journals alike (UNEP, 2006; Yuan et al., 2006; Geng and Doberstein, 2008; Lee et al., 2012; EMF, 2013a, b; Bocken et al., 2017a; HM Government, 2017). Therefore, if we conceptualise a circular economy as a dynamic capability that brings about change, helping firms to achieve resources' productivity, then the definition advanced by Helfat et al. (2007) is the most encompassing. It captures most of the characteristics of the dynamic capabilities as well as including all processes and functions laid out in EMF's circular economy definition (EMF, 2012, 2013b, 2014). If we place both these definitions side by side as in Table 3-6 below, then it allows us to compare both the definitions, as well as bringing out the strategic perspective of the circular economy succinctly through Helfat's (2007) definition.

Table 3-4: Comparing the circular economy and dynamic capabilities definition. Source: Author (2020)

Circular economy definition	Dynamic capabilities definition
The circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and with this, business models (EMF, 2012 p. 7).	A dynamic capability is the capacity of an organisation to purposefully, create, extend or modify its resource base. (Helfat et al., 2007 p. 4).

The phrases 'resource base', 'capacity', and 'purposefully, create, extend and modify' in Helfat's (2007) definition, explains all the processes/ procedures laid out in the circular economy definition, elaborated in the paragraphs below.

The 'resource base', follows from Penrose's (1959) definition of resources, to include all raw materials resources, its wastes, tangible, intangible, and human resources (including capabilities) that a firm owns, controls or to which it has preferential access. The resources that a firm does not own but to which it has preferential access for production also falls under a firm's resource base, as it helps the firm to achieve its desired aim. The resource base also represents the firm's historical endowment of physical raw material resources.

'Capacity' refers to the ability of the firm to perform a task in at least a minimally acceptable manner. This means, if a firm has a dynamic capability, it can alter its resource base in at least some minimally satisfactory manner. Here, Helfat et al. (2007) have introduced the concept of 'technical fitness' and 'evolutionary fitness'. The technical fitness is an internal capability performance indicator that gives the idea of quality per unit of cost. Evolutionary fitness refers to how well a dynamic capability enables an organization to make a living by creating, extending, or modifying its resource base. The factors such as quality, cost, market-demand, and competition influence the evolutionary fitness of a dynamic capability.

'Purposefully' indicates intent and applies not only to dynamic capabilities but also operational (routines, procedures), and functional capabilities. They not only include ongoing tasks for making a living (economic benefits) but can also include environmental and societal benefits achieved through decoupling economic benefits from resources consumption.

The terms 'capacity' and 'purposefully' not apply only to dynamic capabilities, but also to operational capabilities that enable firms to perform their ongoing tasks of making a living.

The words 'create', 'extend', or 'modify' do not apply to operational capabilities alone, which pertain to the daily operations (routines, procedures) of the firm but to dynamic capabilities that alter the resource base of the organisation. These alterations can take many forms. The word ‘create’ includes all forms of resource creation in an organisation, including obtaining new resources through acquisition and alliances, as well as through innovation and entrepreneurial activity. Firms can choose to create or extend their current resource base either for expansion of the same business or change their business to address a new business opportunity including in response to change in the external environment.

If we consider the above explanations, and the strategic nature of the circular economy (cf. sub-section 2.8, fourth paragraph in page 58) then, the circular economy can be construed as a dynamic capability, because it brings about a change to the raw materials resources waste by purposefully creating, extending, and modifying a firm’s resource base. This working definition of the circular economy includes all the elements/ processes/ procedures included in EMF’s definition, such as ‘restorative, and, or, regenerative[20] by intent or design’; ‘closed-loop concept’, ‘eliminating wastes and toxic chemicals’, and ‘designing new business models.’

As a result, this research study shall use this definition as its working definition, which is ‘the circular economy is a dynamic capability that purposefully, creates, extends, and modifies a firm’s resource base’.

This working definition is consistent with the definitions offered by Teece and Pisano (1994); Teece et al. (1997); Teece (2007; 2014b p. 334). It takes into account Teece’s logic that ‘dynamic capabilities do not operate alone […], and the joint presence of strong dynamic capabilities, VRIN resources and a good strategy is necessary and sufficient for long-run enterprise success’.

Teece (2014a, 2014b) introduced the concept of ‘strong dynamic capabilities’, limiting the categorisation of dynamic capabilities to only ordinary and dynamic capabilities. Teece (2014b) introduced strong capabilities whilst addressing the conceptual and bibliographic divide (Eisenhardt and Martin, 2000; Peteraf et al., 2013; Di Stefano et al., 2014)

- ***The debates within dynamic capabilities literature***

The bibliographic divide reported by Peteraf et al. (2013 p.1399) and Di Stefano et al. (2014 p. 314) stems from the differences in conceptualising the dynamic capabilities construct by Teece and Pisano (1994); Teece et al. (1997) and Teece (2007, 2014b) [henceforth TPS][21] on the one hand, and Eisenhardt and Martin (2000) [E&M] on the other. However, both TPS and EM agree on three things, i.e. (a) both agree that the dynamic capabilities framework is an extension of the RBV (b) both focus on managerial as well as organisational processes, and (c) both consider the

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[20] This puts to rest the emerging debate if regeneration or restoration best describes the circular economy.
[21] The use of TPS and EM as acronyms follow Di Stefano et al. (2014).

role of organisational routines as important (Peteraf et al., 2013 p.1392). These represent contrasting but complementary views of dynamic capabilities.

TPS and EM disagree on five things, which are as follows: (a) the nature of the construct, i.e. how dynamic capabilities are conceptualised, (b) the agent, i.e. who exerts it, (c) the action, i.e. by doing what, (d) the object of an action (on which direct object), and (e) the aim or purpose of the construct, i.e. the ultimate goal (Di Stefano et al., 2014 p. 312). The debates ensuing from these disagreements inform us about several dimensions of the dynamic capabilities. Therefore, the discussions in the following paragraphs are limited only to those disagreements that inform the research questions of this research study.

The bibliographic divide stems from one group of scholars aligning to TPS conceptualisation, whereas the other group is supporting EM's conceptualisation of dynamic capabilities. The scholars supporting TPS have advanced degrees in economics, and 'self-report stronger interests in technology, firm performance and strategy'; whereas the 'EM' group' scholars have academic backgrounds in information systems, and training in organizational theory and science or behavioural sciences. EM group of authors are more interested in organizational issues, processes and information systems (Peteraf et al., 2013 p. 1399). It shows that the EM group have more technical leaning, as opposed to the TPS group, who focus more on economic outcomes. Table 3-7 lays out the works from both camps. The debates on the nature of dynamic capabilities benefit this study. Additionally, debates on the role of the agent, i.e. the manager, also contribute to this research.

Table 3-5: Bibliographical divide in the dynamic capabilities' literature. Source (Di Stefano et al., 2014 p. 314)

Bibliographic divide in the Dynamic Capabilities literature			
Domain	**Approach**	**Papers**	**Example**
Nature	Ability /capacity / enabling device	Teece et al. (1997);Teece (2000);Zahra and George (2002); Benner and Tushman (2003);Winter (2003);Knight and Cavusgil (2004);Zahra et al. (2006);Kale and Singh (2007);Teece (2007).	DC refers to the capacity of an organization to purposefully create, extend, or modify its resources or skills. Kale and Singh (2007).
	Process / routine	Eisenhardt and Martin (2000);Amit and Zott (2001);Galunic and Eisenhardt (2001);Zollo and Winter (2002a);Aragon-Correa and Sharma (2003);Colbert (2004);Santos and Eisenhardt (2005);Sapienza et al. (2006).	We define DC as the firm's processes that use resources- specifically the processes to integrate, reconfigure, gain and release resources- to match and even create market change. Eisenhardt and Martin (2000).
Agent	Managers	Galunic and Eisenhardt (2001);Colbert (2004);Knight and Cavusgil (2004);Santos and Eisenhardt (2005);Sapienza et al. (2006);Zahra et al. (2006).	We define [DC] as the abilities to reconfigure a firm's resources and routines in the manner envisioned and deemed appropriate by its *principal decision-maker(s).* Zahra et al. (2006).
	Organizations / firms	Teece et al. (1997);Eisenhardt and Martin (2000);Teece (2000);Amit and Zott (2001);Zahra and George (2002);Zollo and Winter (2002a);Aragon-Correa and Sharma (2003);Benner and Tushman (2003);Agarwal et al. (2014).	A DC is learned and stable pattern of collective activity through which *organizations* systematically generate and modify operating routines for improved effectiveness. Zollo and Winter (2002a).
Action	Change existing	Teece et al. (1997);Eisenhardt and Martin (2000);Galunic and Eisenhardt (2001);Zahra and George (2002);Zollo and Winter (2002a);Benner and Tushman (2003);Winter (2003);Colbert (2004);Santos and Eisenhardt (2005);Sapienza et al. (2006);Zahra et al. (2006);Kale and Singh (2007).	DC are the organizational and strategic routines by which managers *alter their firms' resource base* through acquiring, shedding, integrating, and recombining resources to generate new value creating strategies. Sapienza et al. (2006).
	Develop new	Eisenhardt and Martin (2000); Teece (2000);Galunic and Eisenhardt (2001);Aragon-Correa and Sharma (2003);Benner and Tushman (2003);Colbert (2004);Knight and Cavusgil (2004);Santos and Eisenhardt (2005);Sapienza et al. (2006);Teece (2007).	DC consists of a set of specific and identifiable processes that, although idiosyncratic to firms in their details and path-dependent in their emergence, have a significant commonality in the form of best practices across firms, *allowing them to generate new, value-creating strategies.* Aragon-Correa and Sharma (2003).
Object of action	Competences / resources	Teece et al. (1997);Eisenhardt and Martin (2000);Galunic and Eisenhardt (2001);Zahra and George (2002);Benner and Tushman (2003);Winter (2003);Colbert (2004);Knight and Cavusgil (2004);Santos and Eisenhardt (2005);Zahra et al. (2006);Sapienza et al. (2006);Kale and Singh (2007);Teece (2007).	One can define DC as those that operate to extend, modify, or create *ordinary capabilities.* Winter (2003); (Helfat et al., 2007).
	Opportunities	Teece (2000);Zollo and Winter (2002a);Aragon-Correa and Sharma (2003);Santos and Eisenhardt (2005);Sapienza et al. (2006);Teece (2007).	DC…the ability to sense and then seize *opportunities* quickly and proficiently. Teece (2000).
Aim	Adapt to changing conditions	Teece et al. (1997);Eisenhardt and Martin (2000);Knight and Cavusgil (2004);Benner and Tushman (2003).	*We define dynamic capabilities as the firms' ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.* Teece et al. (1997).
	Achieve an advantage over market rivals	Teece (2000);Zahra and George (2002);Zollo and Winter (2002a);Teece (2007);Amit and Zott (2001).	[DC] enables the firm to reconfigure its resource base and adapt to changing market conditions to achieve a competitive advantage Zahra and George (2002).

- ***Differences arising from the conceptualisation of dynamic capabilities***

TPS (1997 p. 516) conceptualises dynamic capabilities as latent actionable abilities, by defining 'dynamic capabilities as the firm's ability to integrate, build and reconfigure internal and external competences to address *rapidly changing environments'*, whereas Eisenhardt and Martin (2000p. 1107) conceptualise dynamic capabilities in terms of its constituent elements such as the 'firm's processes that use resources - specifically the processes to integrate, reconfigure, gain and release resources to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resources configurations as markets emerge, collide, split, evolve and die'.

EM,, 2000 p. 1111) took objection to the *'rapidly changing environment'* framing of TPS, which indicates that dynamic capabilities construct is applicable to high-velocity markets alone (in EM terms), or to rapidly changing environment (in TPS terms), when other approaches fall short (Teece et al., 1997 p. 509). EM contends that TPS has imposed a boundary condition, arguing that dynamic capabilities are true even in environments that are 'moderately dynamic', but breaks down or find it difficult to sustain in 'high-velocity markets'. Table 3-8 below lists critical differences between TPS and EM.

Table 3-6: Critical differences between TPS and EM. Source: Peteraf et al. (2013 p. 1394)

Critical differences between Teece et al. (1997) and Eisenhardt and Martin (2000)			
		TPS (1997)	**EM (2000)**
Dynamic capabilities and the question of:	**Boundary conditions**	The framework applies to the environment of rapid technological change – 'The approach is especially relevant to Schumpeterian world' (Teece et al., 1997 p. 509).	The framework encounters a boundary condition in such environments; 'encounters a boundary condition in high-velocity markets' (Eisenhardt and Martin, 2000 p. 1118).
	Sustainable advantage	The framework applies to the environment of rapid technological change – 'The approach is especially relevant to Schumpeterian world' (Teece et al., 1997 p. 509).	Dynamic capabilities cannot be a source of sustainable advantage under any conditions. 'As simple rules; dynamic capabilities are themselves unstable' (Eisenhardt and Martin, 2000 1118). As best practices, 'dynamic capabilities are substitutable, thus violating the fundamental VRIN conditions' (Eisenhardt and Martin, 2000 p. 1110).
	Competitive advantage	The framework applies to the environment of rapid technological change – 'The approach is especially relevant to Schumpeterian world' (Teece et al., 1997 p. 509).	Dynamic capabilities can be a source of only limited competitive advantage. .'Dynamic capabilities are more homogenous …than usually assumed.' (Eisenhardt and Martin, 2000 p. 1116).

EM further reasons that placing a boundary condition narrows the utility and applicability of the dynamic capabilities construct for achieving competitive advantage. EM's notion of boundary condition follows from their observation that 'effective patterns of dynamic capabilities vary with market dynamism'. EM differentiates between dynamic and moderate dynamic markets. In moderate dynamic markets, change occurs frequently, but such changes could be somewhat predicted and occur in linear paths. The moderate dynamic markets have relatively stable industry structure, market boundaries are clear, and the players, i.e. buyers, suppliers, competitors, and complementors, are well known. Dynamic capabilities in these markets rely heavily on existing knowledge, i.e. managers apply their tacit knowledge to analyse situations, and plan their activities in a relatively ordered fashion (Eisenhardt and Martin, 2000 p. 1110).

Whereas the characteristics of 'high-velocity' markets have unclear industry structures, blurred market boundaries, unclear business models, and market players, i.e. buyers, suppliers, competitors, and complementors, are ambiguous, and shifting. In high-velocity markets it is not possible to create models for uncertainties as probabilities for managing. This is because of the absence of specific *a priori* knowledge of the continually evolving future states. In such markets, dynamic capabilities rely more on rapidly creating situation-specific new knowledge and less on existing tacit knowledge of the managers (Eisenhardt and Martin, 2000 p. 1111).

EM argues that dynamic capabilities may be true in moderately dynamic markets. However, they have an entirely different character in high-velocity markets, where strategic imperatives are speed and flexibility. Under such circumstances, the 'dynamic capabilities are not complicated detailed analytical processes' but rather 'simple, experiential, unstable processes with unpredictable outcomes.' Due to such an unstable state, 'dynamic capabilities themselves become difficult to sustain in the high-velocity markets' (Eisenhardt and Martin, 2000 p. 1106). '*In high-velocity markets, the duration of competitive advantage is unpredictable. Time is central to strategy, and dynamic capabilities themselves are unstable' argues EM (see Eisenhardt and Martin, 2000 p. 1118). Thus, the logic of TPS, i.e. 'latent actionable abilities', such as to 'integrate, build and reconfigure internal and external competences' for addressing the rapidly changing environments, breaks down.* Possibly, this is the reason for McGrath's (2013a)suggestion to focus on ''transient competitive advantage'' in high-velocity markets. EM's argument is also consistent with Posen's, 2018) contention that imitability increases performance heterogeneity amongst firms because, in the process of copying, imitators learn about knowledge gaps and try to fill them, making them different from the originator. The distinctions between high-velocity markets ('rapidly changing environment' in TPS terms) and moderately dynamic markets are in table 3-9 below.

Table 3-7: Characteristics of markets. Source: Eisenhardt and Martin (2000 p. 1115)

Dynamic capabilities and types of dynamic markets		
	Moderately dynamic markets	**High-velocity markets**
Market definition	Stable industry structure, defined boundaries, explicit business models, identifiable players, linear and predictable change	Ambiguous industry structure, blurred boundaries, fluid business models, ambiguous and shifting players, nonlinear and unpredictable change
Pattern	Detailed, analytic routines that rely extensively on existing knowledge	Simple, experiential routines that rely on newly created knowledge specific to the situation
Execution	Linear	Iterative
Stable	Yes	No
Outcomes	Predictable	Unpredictable
Key to effective evolution	Frequent, nearby variation	Carefully managed selection

EM contends that the dynamic capabilities can be idiosyncratic, but at the same time, they also resemble best practices manifesting themselves as simple routines (Cyert and March, 1963; Nelson and Winter, 1982). For example, product development routines that necessitate creativity, requiring managers to integrate varied skills and knowledge (both explicit and tacit), to bring unique and superior products to market, which have revenue-creating potential for the firm. Similarly, strategic decision-making is a dynamic capability that resembles departmental routines, when managers pull together different experts from different functions, to combine their functional and tacit expertise to define a path for the firm. Thus, while dynamic capabilities are idiosyncratic to a firm, and path-dependent, they resemble best practices in moderate dynamic markets. As a result, performance heterogeneity also stems from best practices, and not only from the dynamic capabilities alone as they themselves are not sources of long term competitive advantage. Thus, it violates the VRIN criteria as it assumes performance heterogeneity consistent across firms. As a result, dynamic capabilities are more equifinal, homogeneous, and substitutable across firms (Brown and Eisenhardt, 1995; Eisenhardt and Martin, 2000).

In response to EM, Teece (2014b, a) argued that best practices could not help a firm to achieve competitive advantage, basing his argument on the two categories[22] of best practices made by Bloom et al. (2012p. 13); and advances the distinction between ordinary capabilities and dynamic capabilities. Teece (2014b p. 338) argues that EM has compromised the essential elements in the dynamic capabilities framework, as the framework has continuously evolved since its inception in 1994. All similar issues were addressed in his previous papers by Teece (2007, 2012, December, 2012, February, 2014b, a). Teece (2014b p. 338) contends that EM possibly targeted a different class of capabilities when they claimed, ‘all dynamic capabilities can be captured as best practices’; as he had already categorised best practices as ordinary capabilities in his 2007 paper (Teece, 2007 p. 1321). Teece (2014b p. 342) blames EM (2000) for conflating ordinary

[22] The two categories of best practices are (a) best operational practices, and (b) best management practices. Speed, quality, and efficiency are example of best operational practices, whereas best management practices continuously collect and analyse performance information setting challenging short and long run target, rewarding high performers and retrain/firing low performers (Bloom et al., 2012)

and dynamic capabilities that benefitted from being analytically separate. Conscious of the earlier categorisation of capabilities into zero-order, first-order, substantive and many more, Teece suggests limiting the categorisation of capabilities to ordinary and dynamic capabilities, only distinguishing between the two, presented in Table 3-10 below.

Table 3-8: Differences between ordinary and dynamic capabilities. Source: Teece (2014b)

	Ordinary Capabilities	Dynamic Capabilities
Purpose	Technical efficiency in a busines s function.	Achieving congruence with customer needs and with technological and business opportunities.
Mode of attainability	Buy or Build (Learning).	Build (Learning).
Tripartite schema	Operate, administrate, and govern.	Sense, seize and transform.
Key routines	Best practices.	Signature processes.
Managerial emphasis	Cost control.	Entrepreneurial, asset orchestration, and leadership
Priority	Doing things right.	Doing the right things.
Imitability	Relatively imitable.	Inimitable
Result	Technical fitness (efficiency)	Evolutionary fitness (innovation)

Teece (2014b p. 338) argues that it is possible to benchmark ordinary capabilities for best practices and that they are prone to imitation. Citing his (2007 p.1321) paper he further reiterates, ‘A well understood and replicable best practice is not likely to be a dynamic capability, therefore, cannot help a firm to gain more than its cost of capital’ or, achieve competitive advantage.

Teece (2014b p. 330) lays out the differences between ordinary capabilities, best practice, and the routine activities that qualify as ordinary capabilities. Accordingly, (a) administration, (b) operations, and (c) governance, are ordinary capabilities; occasionally embedding themselves in some combinations such as (a) skilled personnel including independent contractors (under certain circumstances), engaging with (b) specialised equipment and facilities, and (c) processes and routines managed through (d) administrative coordination, to get the job done. The ordinary capabilities are usually evaluated or measured in terms of the requirements of specific tasks such as labour productivity, inventory turns, and time required for completing, and are, therefore, benchmarked internally or externally to the industry’s best practices. As a result, the process of benchmarking and measurement increases the likelihood of imitation. Ordinary capabilities support technical fitness, whereas dynamic capabilities support evolutionary fitness (Helfat et al., 2007 p. 7&8). Teece (2019a p. 9) argues that ‘ongoing evolutionary fitness’ is the goal of dynamic capabilities. A firm’s ordinary capabilities support technical efficiency, hence leading to productivity regardless of whether such productivity is addressing the competitive needs of the firm. (Teece, 2007, p. 1321). Teece (2014b p. 343)regards product development and alliance formation as ordinary capabilities, in contrast to EM (2000 p. 1111) who considers them as dynamic capabilities; yet in their opinion, such dynamic capabilities are routines or best practices, because they require combinations of different resources that a firm owns, to create products that have revenue-creating potentials for the firm

Teece (2014a p. 20; 2014b p.334) maintains that processes (routines) and resources (positions) underpin the dynamic capabilities framework. Dynamic capabilities rely not just on best practices but 'signature' processes; and not just on any resources but VRIN resources, including proper managerial coordination guided by a 'good strategy'. Thus, Teece differentiates between weak and strong ordinary capabilities and strong dynamic capabilities, as presented in table 3-11 below.

Table 3-9: Elements of the dynamic capabilities' framework. Source: Teece (2014a p. 21).

Core building blocks	Weak ordinary capabilities	Strong ordinary capabilities	Strong dynamic capabilities
Process (routines)	Sub-par practices.	Best practices.	Signature practices and business models.
Position (resources)	Few ordinary resources.	Munificent ordinary resources.	VRIN resources.
Paths (strategy)	Doing things poorly.	Doing things right.	Doing the right things (good strategy).

As a result, the new necessary condition for achieving a durable competitive advantage is the joint presence of strong dynamic capabilities, VRIN resources and a good strategy (Teece, 2014a p. 22, 2014b p. 334, 2019a p. 11). Teece says, 'dynamic capabilities need to be "built" through a process of investment, in discovery, knowledge generation and learning'. Similarly, signature processes could satisfy the VRIN conditions (Jacobides and Winter, 2012), as do the VRIN resources, which also need building (see fig 1Teece, 2014b p. 334).

The working definition of this research study considers the circular economy as a dynamic capability that purposefully creates, extends, and modifies a firm's resource base. This research study has regarded the circular economy as a paradigm that is in its pre-paradigmatic stage (in Chapter 2), which allows it to consider further the circular economy as a dynamic capability that has the capacity to bring about a change to the raw materials resources waste by purposefully creating, extending, and modifying the waste of raw materials resources of a firm's resource base Helfat et al. (2007p. 4). We know from the literature that dynamic capabilities bring change; therefore, if a circular economy can bring change, then it satisfies both considerations. That is, a circular economy could be a dynamic capability that brings about a paradigm shift (change the way we do things – economic growth without consuming more raw material resources).

In Teece's terms, this means the joint presence of the circular economy concept, e.g., 4Rs processes as dynamic capabilities[23], VRIN resources, and a good strategy, become necessary conditions for achieving durable competitive advantage. Therefore, it becomes imperative to investigate how the understanding of the circular economy impacts the VRIN conditions, because it is not the circular economy concept alone that can bring about durable competitive advantage.

[23] Borland et al. (2016) have conceptualised transitional and transformational 5Rs and suggested extending the dynamic capabilities framework's sensing, seizing, and reconfiguring, to include reaping and remapping for achieving ecological sustainability.

For the circular economy to be a paradigm that addresses the tensions between economic, environmental protection, and societal benefits, a good strategy would link to environmental and waste management policies. Against this backdrop, it further reiterates the importance of the research question 3, presented again for easy recollection.

RQ3: How does the understanding of the circular economy affect the characteristics of the resources required for achieving a competitive advantage within circular economy environments?

If the circular economy is a dynamic capability that helps in achieving durable competitive advantage through decoupling economic growth from resource use, then the next logical question from a strategic management perspective would be, what are its implications on policymaking? It is the fourth research question that this research study shall address.

RQ4: What are the policy implications of the circular economy influencing the use of resources?

The circular economy is often referred to as a resource efficiency or a development strategy (European Commission, 2014, 2015, 2017a). As an example, it is used to deliver Europe's 2020 strategy, which is about a smart, sustainable, and inclusive growth Europe. The European Commission (2014, 2017a, 2018), UNEP (2011) as well as the UK Government (HM Government, 2012, 2017, 2018) develops guidelines or paths of action/policies such as Horizon 2020, Waste Framework Directive, Circular Economy Finance support platform to implement a circular economy. Therefore, it becomes pertinent to find how does the altered use of raw materials resources inform policymaking for implementing a circular economy.

3.3.1 Empirical studies on dynamic Capabilities

Looking at previously conducted empirical works on dynamic capabilities would help to substantiate it as a framework for this research study, as this study also employs it to investigate the circular economy in the UK manufacturing sector. Either pragmatist or empiricist positivist traditions underpin most of the previous empirical studies. From Zahra et al. (2006) and Barreto's (2010) reviews of dynamic capabilities, we find that there is not a single study that has used Critical Realist tradition, which makes this study different.

From Table 3-12 below, Galunic and Eisenhardt's (2001) work is useful for this study as it explores dynamic capabilities on the corporate-level processes by which multi-business firms reconfigure their resources. It offers a view of the modern corporation as a dynamic community, focusing on the modularity of corporate resources, the processes (particularly the sensibilities or logics) by which these resources are reconfigured dynamically, as markets and corporate players (business divisions) coevolve; and the broader organizational form that this may constitute. In particular, they emphasize the views of the corporation as a social community, where the basis of dynamic capabilities is founded upon communal imperatives, e.g., encouraging the weak, rewarding the loyal, adhering to conceptions of fairness, even while tolerating competition and conflict and rescuing the stressed; rather than on purely economic reasoning, such as optimizing the technical fit between markets and resources to ensure rent maximization. This study extends (a) perspectives of how modern firms (e.g. circular economy firms) should organize; and (b) describes how organizational structures and processes need configuring, which requires a new underlying managerial logic of adaptability, modularity, coevolution, and self-organization.

Table 3-10: *Empirical studies on dynamic capabilities Source: (Zahra et al., 2006) and Barreto (2010).*

Empirical studies on dynamic capabilities			
Adapted from Zahra et al. (2006) and Baretto (2010)			
Study	**Measurement**	**Research focus**	**Findings**
Danneels (2008)	77 US public manufacturing firms, 2000, 2004.	Antecedents: characteristics of DCs; environmental factors; performance outcomes.	Willingness to cannibalize, constructive conflict, tolerance for failure, environmental scanning, and resource slack are antecedents of marketing and R&D DCs.
Døving and Gooderham (2008)	254 Norwegian small firm accountancy practices.	Intermediate outcomes.	Heterogeneity of human capital, internal development routines, and alliances with complementary service providers influence the scope of related diversification.
Eisenhardt and Tabrizi (1995)	36 Computer-related firms, (72 projects); case studies - multi-respondents per project.	Examined effects of planning, CAD tools, teams, supplier involvement, reward and time schedules on product development time.	Found planning and CAD tools increase the time to develop new products. Cross-functional teams, frequent iterations, leader power, and trial-and-error learning decrease development time.
Galunic and Eisenhardt (2001)	1 Fortune 100 company	Characteristics of DCs.	The DCs consist of a few simple, often competing, rules that enable highly adaptive behaviour.
Brown and Eisenhardt (1997)	Six firms in the computer industry (41 projects); case studies.	Examined the ability of firms to change their competences continuously in response to high-velocity environments.	Reject the notion of punctuated equilibrium and even-based approaches in favour of time-paced responses. Learning and dynamic capabilities creation based on a) well-defined managerial responsibilities and project priorities, b) extensive communication, c) frequent, low-cost experiments and iterations.
McGrath (1995)	23 Financial services firms; over 200 interviews.	Exploratory research to see how firms process and learn from poor outcomes in internal corporate venturing.	Noted three processes to learn from disappointments: a) recognition of failure (measurement, involvement, communication of results) b) interpretation of results into a business model that can be tested c) the action is taken to change routines.
Helfat (1997)	26 largest energy firms over an extended period; historical and secondary data.	Examined to see if the success of responses to changes in external conditions depends on existing stocks of complementary know-how and assets.	Firms with more extensive stocks of complementary technological knowledge and physical assets experienced a more significant increase in capabilities; Yet, such increased capabilities do not compensate for the significant drop in oil prices.
Kor and Mahoney (2005)	60 technology-based entrepreneurial firms	Antecedents of DCs.	Firms with a history of increased resource deployments in marketing will achieve superior economic firm-level performance than firms that lack such deployments.
Rosenbloom (2000)	NCR Corporation	Characteristics of DCs	The role of managers is a central element in DC.
Ahuja and Morris Lampert (2001)	97 global chemical firms; secondary data, especially patent citations	Examined how large corporations create breakthrough inventions and how an exploration of novel, emerging, and pioneering technology helps them overcome competency traps.	Found Inverted-U shaped relationship of exploration of novel and emerging technologies with the creation of breakthrough invention. Found positive relationship of exploration of pioneering technologies with the creation of breakthrough invention. Concluded that continual activity and experimentation are required for firms to renew and reconfigure capabilities.
Feiler and Teece (2014)	Case study of Global Exploration Division of a major IOC, Supermajor EXP.	Dynamic capabilities construct.	This case study explicates the dynamic capabilities framework and shows its relevance to the case. The characteristics of dynamic capabilities that help to differentiate are as follows: (1) how they differ from ordinary capabilities; (2) how they are identified, built and strengthened through managerial processes; and (3) how they function throughout the strategy development and execution process (sensing, seizing and transforming).

3.4 The Resource-Based View and Dynamic Capabilities in the Circular Economy context

Barney 's(1986) argument that competitive advantage stems from picking rent-generating resources from strategic factor markets is underpinned by Penrose's (1959 p. 76) categorisation of the managerial capabilities as a resource, which drives the firm's performance heterogeneity. Thus, a firm's competitive advantage depends upon a manager's ability to exploit market imperfections in both product and resources markets. It extends the role and responsibilities of the manager to include repositioning the firm's resource base as external opportunities change. As a result, the managers' decisions change the nature of competition in markets. The managers' decisions are inextricably reliant upon their perceptions about the internal resource characteristics of their firm, and of the external environment in which they operate (Penrose, 1959). Accordingly, their role becomes both adaptive and proactive (Lado and Wilson, 1994).

Managerial perceptions are essential to both RBV and the circular economy because RBV's three elements, (a) resources functionality, (b) resources combination, and (c) resources creation (Lockett et al., 2009) also help in realizing the circular economy idea of decoupling economic growth from resources use.

- ***Resource functionality***

The issue of resource functionality is deeply rooted within RBV, as Penrose (1959) conceptualised that the size of the productive opportunity of a firm imposes a limit on its growth. She defined 'productive opportunities' available to a firm as, 'all the productive possibilities that its entrepreneurs see and take advantage of'. (1959 p. 31). Thus, the compelling, productive opportunity of a firm depends upon its manager's perceptions as well as on the characteristics that a resource(s) possesses, which are at the manager's disposal. Penrose also suggested that if a firm search for novel use of its existing resources, then it may be able to expand its productive opportunities and exceed its limits to grow. She pointed towards the slack or incomplete use of resources, which provides a potential opportunity for expanding. Penrose also highlighted that firms engage in discovering more about the potential uses of their existing resource bases, as managers often reflect 'there ought to be some way, I can use that' (1959 p. 77). Thus, it is not the resource(s) *per se*, that matters, but its functionality and how a manager employs the resource such that it creates revenue-generating possibilities (Penrose, 1959; Wernerfelt, 1984; Peteraf and Bergen, 2003).

Resources may possess several different potential functions (or, we can say unexercised, unrealised powers), making them employable across many different markets over time. Therefore, managers face the daunting task of understanding the functionality of resource(s) not only that their firm owns, and are under their control; but also, that are under the control of other firms in competition, because ultimately the manager determines the most advantageous usage of a resource. In addition to a resource's functionality, managers also need to know that some resource(s) have a high capacity for usage in many different ways simultaneously.

Therefore, resource functionality is central to decoupling economic growth from resource consumption, because it decides the processes, positions and paths that a firm shall follow to extract maximum benefits from its current resource(s) base(s), and, whether the firm needs to alter its resource(s) base(s).

- ***Resource combinations***

In order to exploit any residual capacity of a resource further, after all the functionality and capacity has been exhausted, the resource(s) needs combining with other available resources. That is, wastes of the resource(s) come into play for generating additional productive services. This is consistent with Penrose's argument that resources are seldom valuable in isolation. Extracting productive opportunities from a combination of waste and virgin resources is dependent upon (a) the process that managers adopt to combine the two resources, (b) the knowledge about the functionality and capacity of the resource(s), and (c) the perception of the manager towards waste. By combining resources, firms may be able to add value if they are complementary (Harrison et al., 1991) or, related (Dierickx and Cool, 1989) or, co-specialized (Lippman and Rumelt, 1982, 2003) in nature. The concepts of complementarity, relatedness, and co-specialization all relate to how resource combinations can create value. This could be goal-specific, such as meeting customers' preferences, or mitigating the resource(s) supply risks. Alternatively, it could also be to conserve the natural reserves of resources (as limited reserves of physical natural raw material resources exhaust very quickly).

- ***Resource creation***

Penrose identified that the unutilized excess capacity within a firm's resource base creates expansion opportunities. Teece et al. (1997), and his colleagues have identified six modes of resource creation, which are elaborated by Bowman and Veronique (2003) as (a) reconfiguration of support activities' (b) reconfiguration of core processes, (c) leverage of existing resources, (d) encouraged learning, (e) provoked learning, and (f) creative integration.

- ***Dynamic capabilities, circular economy, and the next generation competition***

The firm managers' ability to exploit different functionalities through resources combinations, or creating new resources, or new productive services is central to the dynamic capabilities literature; because, this mainly involves integrating productive activities to reconfigure internal and external competencies, through the simultaneous deployment of resources and factors of production (Teece and Pisano, 1994; Teece et al., 1997). Newer technologies further augment exploiting the residual capacities of used resources (wastes) through combining and recombining processes. As a result, new technologies transform the structures of markets as well as the competition policies (Teece, 2018a; Bailey et al., 2019a). Teece (2012, February p. 99) refers to these new markets structures and competitions as 'next-generation competition'. He recognises next generation competitions to have fluid market structure, clusters of know-how, globally dispersed technologies, and an innovation that is driven by combining and recombining of resources and technologies. Table 3-13, adapted from Teece (2012, February p. 99) compares the next generation competition with conventional competition.

Table 3-11: Old and new modes of competition. Source (Teece, 2012, February p.99)

Old and New modes of competition	
Conventional Concept	**Next-Generation Competition**
Static Competition	Dynamic Competition
The West and the Rest	A Semi-globalized world
Industry-level analysis	Eco-system level analysis
Vertical integration	Modularization
Transaction and Agency cost	Firm-level capabilities
Single invention innovation model	Multi-invention Innovation model

In Teece's terms, Industry 4.0 could be enabling the circular economy, as it enhances 4Rs processes. Closed loops, industrial ecology, industrial symbiosis, and similar concepts/ frameworks used in understanding the circular economy represent the next generation competition (Blunck and Werthmann, 2017; Lopes De Sousa Jabbour et al., 2018; Rajput and Singh, 2019). Smart factories can simulate production processes before physically using the raw material resources, which makes it possible to have mass production of a batch size of one (Stock et al., 2018 p.257). Thus, technology has emerged as the key driver for the circular economy, linking it to technology platforms and ecosystem architectures. In turn, it opens up new opportunities to pursue economic growth, reducing the use of raw material resources. This is possibly the reason the circular economy has come to be known as the 'platform economy' (Evans and Schmalensee, 2008; Evans, 2011; Evans and Gawer, 2016; Igor et al., 2016); the 'Gig economy' (Martin, 2016; Frenken and Schor, 2017) or 'sharing economy' (Cockayne, 2016; Frenken and Schor, 2017; Schor, 2017).

Platforms help in decoupling economic growth from resources consumption. This is because they are components of an ecosystem where assets are shared systematically for product development across a family of products, enabling quick joint innovation by using and reusing common assets (Krishnan and Gupta, 2001) - representing a typical industrial symbiosis architecture.

Teece (2012, February p. 104) states,

> 'An ecosystem may be anchored by a platform-dependent upon common standards and interfaces and usually driven a platform leader. Platforms are usually proprietary such that patents or copyrights usually protect the standards. Platforms typically result in specialization by ecosystem members, resulting in shorter developmental cycles for new products and services. The viability of any business ecosystem depends upon the platform innovator cooperating with the providers of complements and vice versa. Members or participants in the ecosystem collectively address the competition of rival ecosystem.'

They are also widely known as technology platforms, and there are numerous examples in the digital sector, for example Google, Apple, or Facebook. They are also 'platform leaders' (Gawer and Cusumano, 2002), also known as 'keystone firms' (Iansiti and Levien, 2004). Each of these firms plays an orchestrating role within the network of firms and individual innovator developers, and therefore collectively it is known as an 'innovation ecosystem' (Adner and Kapoor, 2010) or 'ecologies of complex innovation' (Dougherty and Dunne, 2011). Several top FTSE100 companies, such as Cisco, Ericsson, General Electric, Google, IBM, Intel, Microsoft, Oracle, SAP, Texas Instrument, and Qualcomm, are working as ecosystem captains. They create the Industry 4.0 ecosystem, presenting the possibility of developing a circular economy ecosystem (Blunck and Werthmann, 2017; Lopes De Sousa Jabbour et al., 2018; Rajput and Singh, 2019). Out of these top FTSE100 companies, Cisco, Google, IBM, Microsoft, and SAP, are members of the CE100 club, the paradigm community, which is influencing the understanding of the circular economy.

Gawer and Cusumano (2013 pp. 418 & 419) differentiate between internal platforms and external platforms. They define 'internal (company or product) platforms as a set of assets organized in a common structure from which a company can efficiently develop and produce a stream of derivative products' (Muffatto and Roveda, 2002). External platforms are those platforms where 'one or more firms develop products, services, and technologies, and which serve as foundations upon which a large number of firms can build further complementary innovation and potentially generate network effects' (Gawer and Cusumano, 2013 p. 420). Networks effects, in turn, help to achieve economies of scope and scale and trigger self-reinforcing cycles of growth (Evans and Gawer, 2016).

In the context of the circular economy, each firm involves its suppliers, designers, and production processes generally to develop their internal platforms. This teaming favours reuse of components, achieved through modularisation and standardisation of design, often involving incremental innovation[24]. Designers and engineers reuse their designs from previous work, thereby reducing wastage of raw material resources for new product development, emphasising low cost and reducing time to market (Baldwin and Clark, 2000; Baldwin and von Hippel, 2011). Thus, such new product development processes represent ordinary capabilities, as argued by Teece (2014b p. 343) to defend his positions against EM's (2000), claim that product development and alliance formation are ordinary capabilities and not dynamic capabilities.

Further, in the context of a circular economy, the technology platform architectures have facilitated two side market or multi-sided market structures. The critical feature of multi-sided markets is that they generate network effects on two sides of the market and under certain conditions drive competition between platforms, triggering self-reinforcing feedback loops (Moore, 1996; Armstrong, 2006). The author has conceptualised the multi-sided markets structure for the circular economy presented in figure 3-1 below, which resulted by juxtaposing the ReX taxonomy (e.g.4R processes) and VROs (value retention options)[25] presented in Appendix 7.

[24] This idea is not new as it was in use in 1854 by Baldwin Locomotive Works as they developed a rigorous program to standardize locomotive parts, which could be used across many Baldwin standard engines or even in custom designs.' It is explained by Brown (1995 p. 21) in his history of Baldwin Locomotive Works, (excerpts taken from Gawer and Cusumano, 2013 p. 418, emphasis added). During the mid-1800s, probably, the US manufacturing industry too was looking for conserving resources similar to what the European Union is currently doing. The reason to think this way is because antecedents of the circular economy reveal that the circular approach existed during the 1840s. It is reflected in the famous speech of R.W. Hoffman, the first President of the Royal Society of Chemistry. He stated '…in an ideal chemical factory there is, strictly speaking, no waste, but, only products…The better a real chemical factory makes use of its waste, the closer it gets to its ideas, the bigger is the profit.' (Rothenberg et al., 2002 p. 26 emphasis added).

[25] Please see figure 8-1 in Appendix 7.

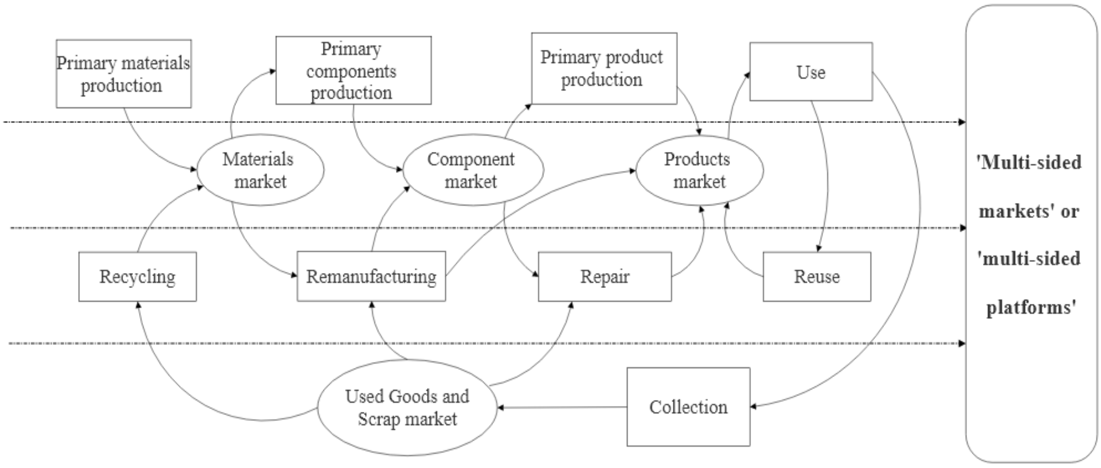

Figure 3-1: Conceptualisation of the circular economy markets as multi-sided markets. Source: Author, adapted from Zink and Geyer (2017 p. 597).

Such multi-sided markets facilitate collaborative consumption (Rochet and Tirole, 2006; Adner, 2017; Park and Armstrong, 2017); coopetition (Brandenburger and Nalebuff, 1996; Brandenburger and Stuart, 1996); complementarities (Teece, 2018b); co-creation and co-evolution (Teece, 2018a; Pitelis and Wang, 2019), compelling firms to change business models. (Baden-Fuller and Haefliger, 2013; Adner, 2017), thereby creating market disruptions (Hagiu and Wright, 2015; Cozzolino and Rothaermel, 2018; Cozzolino et al., 2018).

Thus, the next-generation competition is in a dynamic state and ever-evolving, which blurs the market structure. As a result, industry-level analysis cannot depend upon market structure alone, as it used to be in the industrial organization or in the 'Five-forces' model (Porter, 1980; Teece, 2012, February), requiring conceptualisation of new economic models and regulatory frameworks. Therefore, Teece (2018a) suggested that 'the concept of an ecosystem may substitute the industry-level analysis as a useful domain for performing economic analysis'. McGrath (2013a p. 9) has also raised concerns regarding industry-level analysis, arguing that it is not fine-grained enough to determine what is going on at the industry level.

Conclusively, the circular economy and its emergent market structures are inclined towards the dynamic side of the static-dynamic continuum, with blurred boundaries, fluid structures, clusters of know-how and looming uncertainties from multiple sides. This market structure resembles the next generation competition described by Teece (2012, February). Technology leadership is central to extracting residual capacity from waste and virgin resources through different modes of resource creation, i.e. through the combination, recombination, and reconfiguration and integration processes.

3.5 The conceptual framework for investigating the circular economy in the UK manufacturing

The information gathered from the resources and capabilities literature review informs the conceptual framework for this research study, represented in figure 3-2.

a. The new conditions laid out by Teece (2014b, 2019a) for achieving competitive advantage.

b. The learnings from Eisenhardt and Martin (2000) and Teece's (2014b, a) debates about the conceptualisation of the dynamic capabilities.

c. The new modes of competition resulting from technological advancement explained by Teece (2012, February); Gawer (2013; 2014), Evans and Gawer (2016); Jacobides et al. (2018); Ozalp et al. (2018); Elmquist et al. (2019), and

d. Applying RBV in terms of resources functionality, resources combination, and resources creation (Lockett and Thompson, 2001; Lockett, 2005; Lockett et al., 2009).

The new condition advanced by Teece is that, in order for a firm to achieve a durable competitive advantage, the joint presence of strong dynamic capabilities, VRIN resources, and a good strategy is a necessary condition.

From the debates, we know about (a) the characteristics and nature of moderately dynamic markets as well as dynamic markets, (b) the differences between ordinary capabilities and dynamic capabilities, and (c) differences between old and new modes of competition. Further, the dynamic capabilities literature informs us that processes are also capabilities. Therefore, the 4R processes such as reduce, reuse, recycle and recovery, found to buttress most of the concepts/ frameworks used to understand the circular economy, are similar to resource creation, advanced by Teece and his colleagues in 1997. It ties in well with resources functionality, resource combinations, and resource creations, (Lockett et al. (2009), which is backed by the idea that it is not the resources that are important, but the services rendered by the resources (Penrose, 1959).

Consequently, the conceptual framework in figure 3-2 enables us to investigate how UK manufacturing firms are implementing their understandings of the circular economy. In turn, it would inform us what the circular economy means to manufacturing businesses, and how they use their resources bases for achieving competitive advantage.

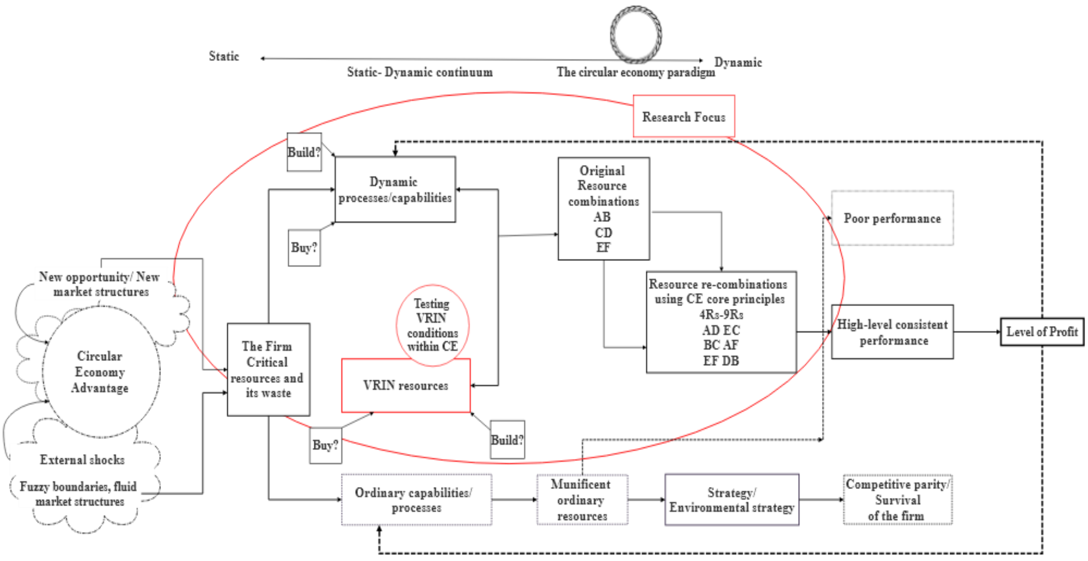

Figure 3-2: Conceptual framework for the research study. Inspired by (Teece, 2014b p. 334, 2019a p. 11)

In figure 3-2 above, the two arrows originating from the firm and going in opposite directions signify new paths that might be available to the firm, because of external shocks or new opportunities (Zahra and George, 2002). They cause the firm to respond to external stimuli by either reconfiguring its critical resource bases through different dynamic processes to build in-house, or by buying resources and capabilities from the factor markets.

The conceptual research framework leads to seven steps, which bring about a structured approach for answering the research questions. The steps are as follows:

3.6 The Seven Steps for Investigation

The working definition is 'the circular economy is a dynamic capability that purposefully, creates, extends, and modifies a firm's resource base'.

First Step. ***About the industry:*** Ascertain where industry lies on the static-dynamic continuum by identifying the industry structure and trends prevalent in the industry, using Tables 3-6 and 3-7. Also explore if the focus industry is experiencing any external shock. Shock includes changing economic conditions (such as a recession), political events (such as Brexit), and technological shift (Internet of Things or Internet of Everything, or the influence of Artificial Intelligence), or any other kind of shock(s).

Second step. ***About the manager***: Finding the role, responsibilities, academic background and past work experience of the interviewee. This insight is mainly about identifying a manager's capabilities.

Third step. **About the firm:** To find out about the background of a firm's raw material resources endowment, and its response to maintain and deal with scarce and short-supply resources.

Fourth step. ***About the firm's understanding of the circular economy:*** To find the personal and institutional understandings of the circular economy through the lived examples of the interviewees.

Fifth step. ***About the firm's practice of the circular economy:*** To find out how the circular economy translates into practice through initiatives taken for the raw material resources use. For example, by the use of renewable materials and energy, value extraction from resources through deploying dynamic processes (developed creatively in-house, proprietary signature processes or, following any of the '3Rs, 4Rs, 5Rs, 6Rs, 7Rs, 8Rs, or 9Rs', processes). Identify if there are any disruptive technologies developed in-house or bought from external sources.

Sixth step: ***About the firm's wastes:*** Investigate how the firm manages its waste. Suppose that there is a written document on waste management policy. Alternatively, does the firm consider waste management on an ad-hoc basis?

Seventh step: ***About the profit:*** Identify the notion of profit that the firm follows.

The details of how these stepwise activities inform the research questions are as follows:

Having established that the circular economy is inclined more towards the dynamic side of the static-dynamic continuum, portrayed at the top of figure 3-2, **Step 1** would be to gather information about how the industry responds to the external shocks, identified opportunities, and latest trends. This information would help in estimating the readiness of the Case industry and the firm for embracing the circular economy. This information will feed into answering RQ1.

Step 2 is about knowing 'the manager', as we already know that the 'Manager/ entrepreneur' is, central in all leading theories such as Penrose, Barney, Schumpeter, and Teece, that underpin this research study. Therefore, knowing the manager's predisposition becomes key to understanding how the circular economy is implemented at the firm level. Therefore, information about the manager's academic qualifications, past work history, and current roles and responsibilities, is crucial for answering the research questions 1, 2, and 3.

Step 3 would also help in understanding how the firm secures its critical resources for keeping production going. Finding a firm's historical resource positions and current initiatives for securing a continuous supply of raw material resources for production would provide information for answering not only research question 1 but also research questions 2 and 3. It will also reveal information about the top management team's attitude towards the circular economy.

The manager's predisposition and background would allow for revealing just one empirical layer, while **Step 4,** seeking lived examples of the interviewees, would provide a broader base of how an understanding of the circular economy translates into practice. Step 4 would bring forth theory-practice and saying-doing contradictions. This step would feed back into answering RQ1 and RQ2.

Step 5 tracks different processes across the firm that are in use for addressing resource supply risks and price fluctuations, ensuring uninterrupted production. This step informs RQ3, as it would deal with both dynamic and static processes, investigating whether processes are build or bought. This step would uncover the characteristics of resources that the case firm seeks to build or buy, thereby helping to answer RQ3. Also, it would inform RQ4.

Step 6 takes an alternate route to find the handling of the resource after its first use. It investigates how the case firm treats its waste materials. This step feeds into answering research questions one and two, and bringing forth theory-practice or claim-practice contradictions. Besides, this step would also feed into RQ4.

Step 7 is about understanding the notion of profit, followed by the case firm. This step would further enlighten research questions one, two and three. It would help to bring forth the reality of the circular economy, helping to explain if the firm signed up to the circular economy, intending to restrict its resources use just for economic gains or for environmental and societal benefits as well. This step would also feed into answering research question four.

3.7 Conclusion

The literature review on resources and capabilities reveals that (a) the notion of competitive advantage is based not on the concept of advantage, but the concept of costs and profit. In neoclassical economics, profit is illusory or challenging to achieve, because costs and profit calculations are problematic, indicating that profits and costs need reconceptualising. This conceptualisation, in turn, would also change the current notion of competitive advantage, which is also the need of the hour, taking into consideration 'greenwashing', and the rate of depletion of the reserves of the natural raw material resources. b) The circular economy paradigm provides an opportunity for durable competitive advantage without consuming resources. It would promote revenue growth without straining the reserves of natural raw material resources, which, in turn, ensures environmental protection. Reducing consumption would lead to creating societal benefit. Thus, a circular economy would qualify as a paradigm, because, possibly, it can manage the tensions across the three dimensions of economy, environment, and society, which sustainable development has not been able to manage. (c) However, this would require understanding the types of resources that support the decoupling of economic growth from resource consumption, and, therefore, the conventional VRIN framework requires testing in the context of a circular economy. This assessment would help to answer the third research question.

The debates emanating from the conceptualisation of dynamic capabilities inform us about:

a. The nature of markets - whether they are high-velocity or moderately dynamic markets.

b. How to distinguish between ordinary and dynamic capabilities.

c. Distinctions between strong ordinary capabilities and strong dynamic capabilities, and

d. The characteristics of physical raw material resources and managers' resource picking skills that are still crucial for achieving a durable competitive advantage.

Thus, all of this helps us to conclude that the circular economy business ecosystems are high-velocity markets having multiple sides with blurred boundaries. There are clusters of know-how, which help extract unused capacities of resources, and create the possibility of achieving durable competitive advantage, without straining the existing reserves of natural raw material resources.

All of the above information helps to develop a conceptual framework for investigating the understanding of the circular economy within the UK manufacturing sector; which in turn will help to determine the more realistic concept that best describes the circular economy. This realistic concept would also facilitate a uniform understanding of the circular economy, which is the need of the hour because manufacturing firms spend approximately forty per cent of production costs on procuring raw material resources.

Therefore, the next chapter lays down the strategies to investigate detailing the philosophical lens that it would use to access knowledge about the circular economy.

Part Two

Chapter 4 Research Methodology

4.1 Introduction

Whenever we want to know about something that exists, there is usually a chain of argument that follows, such as we start by asking, 'What exists?' We then realise that to gain knowledge of what exists, we have to access it via our linguistic or discursive apparatus to obtain an understanding of it. 'The next step, however, seems unwarranted. We conclude that because whatever exists is mediated by our linguistic or discursive practices, then by this unwarranted step, reality becomes something that is entirely socially constructed through such linguistic and discursive practices. An ontological question 'What exists?', is translated into an epistemological problem. That is, how can we know what exists? Thus, we socially construct the entire reality of whatever exists through our language and discursive practices' (Martin, 2007 p. 37). The current understanding of the circular economy seems to follow a similar process, because, thus far, our knowledge about the circular economy is based either upon our *a priori* knowledge of similar concepts/ frameworks, or upon our lived experiences. That is, 'the epistemological knowledge' becomes 'the ontological knowledge' of the circular economy. It also means that there is the objective reality of the circular economy that exists, and which is possibly different, but knowable and describable - albeit with a caveat, that all knowledge claims are fallible (Bhaskar, 1978; Collier, 1994; Spash, 2012, 2020).

Therefore, this research focuses on gaining ontological knowledge of the circular economy. This focussing is to acquire insights into its nature and composition because thus far, no studies have investigated the ontological perspectives of the circular economy. The author expects that the endeavour to access ontological knowledge of the circular economy would bring out its fundamental nature and characteristics, as these form the basis of the existence of any object/entity, and do not change unless until influenced by an external stimulus. It would facilitate a uniform and shared understanding of the circular economy. Knowledge of nature and characteristics would also help in realising economic growth by limiting the resources consumption. It would, in turn, allow us to include the other two dimensions (environmental and societal), which are currently being left out of the circular economy discourse, as we have already witnessed in chapter 2 (UNEP, 2011; EMF, 2012, 2013b, 2014; UN, 2015; Ghisellini et al., 2016; Domenech and Bahn-Walkowiak, 2019). However, critical realism focusing on ontology does not mean that it neglects epistemology. In a way, critical realism keeps ontology and epistemology separate (Ackroyd and Fleetwood, 2000 p. 6).

This chapter is, therefore, organised in two sub-sections. Sub-section 4.1 deals with explaining critical realism in the context of this research, as our philosophical position helps in setting out the grounds and defines our methodological choices (Sayer, 2000). Sub-section 4.2 details the research design that this study adopts. This approach is consistent with Sayer (1992) as he suggests our choice of 'methods'[26] must be influenced by the purpose of underpinning the study and object of our endeavour. For example, if we want to find the reaction of a particular chemical with other chemicals, then an experimental method may be appropriate. Still, if we were investigating the meaning of work for individuals within a given context, then a more qualitative or hermeneutic approach would be appropriate. Endeavouring to find the ontological perspective of the circular economy is also consistent with Archer (1995), as she suggests that ontology plays a critical regulatory role, to quote:

> 'for they govern those concepts, which are deemed suitable in explanation as in the description. Precepts for proper concept formation come from the social ontology, which is endorsed, as this logically determines the type of descriptive concepts, which can be employed […]therefore it is important to recognise that ontological considerations are used not merely to justify congruent methodological standpoint, but actively regulate the associated explanatory programmes' (Archer, 1995 pp. 21-22).

The structure of this chapter runs as follows. Sub-section 4.1 explains the critical realism that is applied to conduct the research study, emphasising the concepts used and justifying the choice of critical realism over other philosophical traditions. The sub-section 4.2 details the research design, explaining the comparative case study approach undertaken, including details such as samples, their sizes, coding and data analysis. Ethical considerations are in subsection 4.3. The chapter ends with a conclusion in sub-section 4.4.

4.2 Using critical realism to investigate the circular economy within UK manufacturing firms

Defining critical realism is difficult. However, it situates itself as an alternative paradigm consisting of a series of philosophical positions on a range of matters. These include ontology, causation, structure, person, and forms of explanation. Bhaskar Roy is the proponent of critical realism. It developed initially by vindicating science as exemplified in positivism (Bhaskar, 1975, 1978). Also, in the idealist view of social sciences represented in constructivism and interpretivism (Bhaskar, 1979). Later Bhaskar Roy, (1989) engaged with post-modernism and

[26] Sayer (1992) has taken a broad view of the term 'methods.' According to him, in addition to research design and method of analysis, 'methods' also includes clarifying the modes of explanation and understanding, and the nature of abstraction.

other non-realist viewpoints through immanent critique and developed his position, which he articulated in his writings on dialectic perspectives (Bhaskar, 1993, 1998, 2000, 2012). The critical realists often also draw from the works of Bhaskar as well as other critical realists scholars, because Bhaskar passed away before he could complete his writing on how to operationalise critical realism for research. Scholars who have expanded the works of Bhaskar includes are, for example, see Sayer (1992), Collier (1994), Archer (1995), Ackroyd and Fleetwood (2000), Fleetwood (2005), Martin (2007), Elder-Vass (2010), Mingers et al. (2013), Price and Martin (2018), Martin (2020), and many others.

Since critical realism involves a series of a philosophical positions it cannot be compartmentalised. However, we can broadly frame it for our understanding, and interpret it to consist of (a) 'basic critical realism' (b) dialectic critical realism, and (c) the philosophy of metaReality (Bhaskar, 2017 p. 6). Critical realism is methodologically plural, and a reflexive philosophical stance concerned with providing a philosophically informed account of science and social science, which in turn can inform our empirical investigation (Archer et al., 2019).

The reasons for choosing critical realism as the philosophical lens for this research study stem from the pieces of evidence derived from the circular economy literature review. That is, the presence of the paradigm community in driving the circular economy narrative, influencing and shaping its understanding, indicates the probability of a stratified reality of the circular economy having structures and mechanisms in play, which are not empirically evident. Also, the conceptually mediated understanding of the circular economy points to the underlying causal mechanisms which, if explored, could open the possibility of addressing irregularities. It, in turn, can facilitate understanding of the ideally real circular economy[27] that can drive a unified understanding across sectors. With this view, this research study shall employ concepts drawn from (a) basic critical realism, and (b) dialectic critical realism, to identify the 'ideally real circular economy', the powers it possesses, by absenting the absences. This research study shall not use the concepts from metaReality as it is beyond the scope of this research study.

The concepts that this research study shall use from basic and dialectic critical realism are (a) the concept of laminated reality, (b) the concepts of causal powers or generative mechanisms, (c) the concept of emergence from basic critical realism, and (d) the concept of absence and negation from dialectic critical realism, including the notion of transitive and intransitive objects. Accordingly, the meaning of these concepts and their relevance for this study are laid out as follows:

[27] The 'ideally real circular economy' has been referred as 'whole circular economy' in chapter 2.

a. *The concept of laminated reality*

Critical realism states that there is a world, which exists beyond and independent of our conscious perception. We can know some aspects of this world through our senses, but we cannot rely entirely upon our senses, because sometimes our illusions can fool us or lead us to misinterpret our sense data about any event(s). Since reality is independent of our perceptions, any events that impact reality continues to operate (impact), despite our interpreting it correctly or misinterpreting it, and irrespective of our being aware or not aware of it. In practice, the distinction between what happens, e.g. an event, and what we perceive has happened, and the underlying (possibly unobservable) mechanism(s) that caused that event to happen, are the key aspects of critical realism.

Bhaskar (1975) made a distinction between different objects of knowledge in the world, defined as transitive and intransitive objects. Intransitive objects are the 'real things and structures, mechanisms, and processes, events and possibilities of the world; and for the most part, they are quite independent of us' (Bhaskar, 1975 p. 22). It means an intransitive object can exist without our knowledge or perception about it, e.g. trees falling in a forest. On the other hand, transitive objects include theories, paradigms, models, and methods, and these often exist without us knowing either! The intransitive objects are subjective, and their existence is dependent upon on our (human) activit(ies) for example if people suddenly cease to exist, then these transitive objects would also cease to exist.

Besides distinguishing between intransitive and transitive domains of knowledge, critical realism views reality (ontology) to be stratified, i.e. distinctly divided into three domains: the real, the actual and the empirical, as shown in table 4-1 below.

Table 4-1: Ontological assumptions of the realist view of Science. Source Bhaskar (1978 p. 13)

Domain	Explication	Consisting of
Empirical	Events which are directly experienced by the observer	Experience
Actual	Events whose existence is granted regardless of whether they are observable or not.	Experiences + Events + Non-events that are generated by mechanisms.
Real	The processes that generate the events, the underlying generative mechanisms	Events + Events + *Structures and mechanisms*

Table 4-1 explains the three ontological layers. It means that the location of causal powers is in the real domain. The activation of the causal powers gives rise to patterns of *events* in the actual domain, which in turn when identified, become *experiences* in the empirical domain (Ackroyd and Fleetwood, 2000 p 28). Further, the limitations of our senses imply that we would not be able to perceive all traces of events, and the subjective and perspectival nature of our senses means that experiences will vary from person to person.

Behind events, there are structures and generative mechanisms that have enduring properties. The enduring properties mean that even if we cannot observe or perceive an event, the enduring properties of the structures and generative mechanisms continue to act, leaving empirical traces, which can be observed or experienced by the human agency(Bhaskar, 1975). This stickiness is the reason for tracking the empirical traces of a circular economy within the historical roots of sustainable development, and in other waste prevention concepts /frameworks in chapter 2.

Such generative mechanisms have been referred to as *alethic truths* by Bhaskar (1998), because it is mechanisms such as these that give rise to both actual and empirical events and the phenomena that a researcher (scientist) seeks to identify.

For critical realists, superior explanatory power comes from considering entities as standalone, having their rights and identification, which interact with others to cause events that we either observe and experience or, we do not observe but experience. In other words, explanatory power lies in understanding how each entity relates as part of a greater whole. It means an entity is real 'if it has causal efficacy; can affect the behaviour; and makes a difference' (Fleetwood, 2005 p. 199). Fleetwood (2004) extends the notion of intransitive and transitive entities (objects) by identifying four different ways for differentiating entities, such as: materially real, ideally real, artefactually real, and socially real.

'Materially real' are material entities such as oceans, the weather, the moon and mountains, which can exist independently of what individuals or communities do, say, or think. '**Ideally-real'** are conceptual entities such as discourse, language, genres, ideas, understandings, explanations, opinions, concepts, models, and theories. **'Artefactually-real'** are entities such as cosmetics and computers. **'Socially-real'** entities are practices, states of affairs, market mechanisms, or social structures that constitute an organisation. (Fleetwood, 2005 pp. 199-201). Following on from this categorisation, this study aims to situate itself within an ideally real domain. It brings up the point then, that this study wants to know the 'Ideally-real of the circular economy', in order for it to facilitate a unified understanding across all sectors.

Fleetwood (2005) says confusion often stems from (mis)treating real material entities synonymously. It could also stem from (mis)treating non-material entities synonymously with non-real entities. 'God may or may not be real, but the idea of God is as real as Mount Everest because the idea of God makes a difference to people's actions'. (2005 p. 199) Similarly, climate change is happening, irrespective of our knowledge about it, and as an entity it has causal effects that are not readily observable but are experienced. In a similar vein, the understanding of the circular economy could have a causal impact on how firms use their resource base across all sectors. The author has reiterated this earlier in chapter 2. That is the need for knowing a 'whole circular economy' (or the ideally real circular economy). This would facilitate a unified understanding of it across all sectors, which in turn would improve the uptake of circular economy projects by investors, which is currently lacking (European Commission, 2018).

b. The concept of the causal powers or generative mechanisms

The context is vital for understanding how each entity relates as part of a greater whole. For example, in order to understand what a heart or a coin is, it is essential to place the heart in the context of the human body, and the coin in the context of the monetary system. Research should, therefore, consider all when attempting to understand and explain a paradigm or a phenomenon (O'Mahoney and Vincent, 2014).

O' Mahoney (2011 p. 726) contends that the properties/ characteristics of entities represent their 'essence' and 'causal powers'. An essence is 'what makes something that thing and not something else'. For example, water (H_2O) has the power to soak; a company's director has the power to employ; money has legal status and power to purchase. Similarly, the notion of causal power is useful to understand change because change often occurs when the power of one entity interacts with the power of another entity. For example, the power of fire can heat cold water. Similarly, teams have the power to elect a leader. Capabilities are understood to have causal powers to bring about change (Martins, 2006). Based on this logic, the working definition of the circular economy in Chapter 3 considers a circular economy as a dynamic capability to mean a circular economy possesses the causal powers to purposefully create, extend, or modify a firm's resource base to secure future cash flows for the firm. However, investigations within UK manufacturing firms would reveal how such causal powers unfold in real-life business settings.

Such mechanisms often transform entities; for example, the fire that heats water could transform water into steam; the new leader might use dynamic capabilities to develop a new strategy that could change the organisation. As a result, the changed entities or emergent entities often have new properties and powers. The expectation is that the causal power of the circular economy could help to change firms, which could help them to manage tensions across the three dimensions - economic, environmental, and societal.

Powers may be possessed, exercised, or actualized. An entity can have power just because of its properties when it is not acting; for example, gunpowder has the power to explode, or the state has the power to spy on one's internet activities. This power may get exercised when the power is triggered, i.e. the state chooses to spy on your internet activity, or you need a spark to trigger gunpowder. However, the power may not get actualised because of the countervailing powers present, for example, the presence of anti-spy software on a computer or the state spying on the wrong IP address. The social world is full of powers, and the exercise and actualisation of such powers are dependent upon the location of these powers in an open system. The potential of entities to possess powers that they can either exercise or actualised gives a critical realist the tool required to understand the social world in a more sophisticated and nuanced manner. This notion contrasts with constructivist or empiricist approaches, which consider things either are or are not. Bhaskar (1978) referred to such ontology as being a flat ontology.

c. The concept of emergence

The organisation of entities can be hierarchically such that they exist at different levels. For example, 'organizations' are made up of people (among other things). Tissues and organs make up people; cells make up tissues and organs; and so forth. It means it is possible to analyse entities at different levels of aggregation. Also, it is not always the case that the lower entities determine the top layer; however, one cannot rule that this is not the case. At this point, the crucial critical realist concept of emergence starts to exist. Emergence happens 'when an entity has causal properties that are greater than the sum of its 'lower-level' parts' (Elder-Vass, 2010; O'Mahoney and Vincent, 2014 p 7). For example, water (H_2O) has properties that individual quantities of hydrogen and oxygen do not.

Similarly, in the social world, teams can do things that an individual member cannot do independently. Irrespective of entities, the crux of the matter is that properties of the collective whole are not reducible to the properties of the parts that constitute it. Therefore, critical realist accounts have depth because they take an interest in both the collective whole as well as how each part tends to associate itself. It helps in developing a better understanding of the lamination and emergence at the hierarchical level. Therefore, water and teams are entities in themselves and not merely an assembly of things that constitute them.

Another critical point is that each entity has emergent properties, but is irreducible to its lower-level components. For example, water has a 'wetness' property that would not exist if hydrogen and oxygen were separate, even though neither oxygen nor hydrogen feels wet themselves.

Collier (1994) gives an example of the 'minerals kingdom' that is governed by laws of physics and chemistry, and the 'plants and animals kingdom' by the laws of botany and zoology. The plants and animal kingdom does not break the laws of botany and zoology, nor does the mineral kingdom break the laws of physics and chemistry; because they all are composed of atoms, and those atoms obey the same laws, irrespective of them being a part of living organisms or not. However, the biological and physico-chemical laws govern the plants and animals kingdom, and not the minerals kingdom, yet it affects the minerals kingdom. Therefore, for explaining what happens to stones in the garden, one must know the habits of the ants. Likewise, in order to explain the damage done to the ozone layer, one must know the laws of economics. In the context of a circular economy, it is about looking for clues that are in play but not observable, such as the notion of profit that firms follow, or how they consider waste?

d. *The concept of absence and negation*

Absence and negation are central to dialectic critical realism, the second amongst three sets of tools that critical realism offers to explore the ontological reality. Thus far, we have discussed an argument for ontology and against its reduction to epistemology. Dialectical critical realism, commonly referred to as DCR, has four levels, known by the acronym MELD (Bhaskar, 1993 pp. 238, 270, 276, 2017 p. 57).

1. The first level **1M** is a level which thinks or understands 'being' as such, and 'being' as non-identity.

2. The second level **2E** explores 'being' as a process, and 'being' as involving negativity, change, and absence.

3. The third level **3L** explores Totality i.e.,' it is essential to disconnect, separate, distinguish, and divide, that differentiation is a necessary condition of totality and diversity of unity'.

4. The fourth level **4D** understands 'being' as incorporating transformative praxis.

The second level 2E is of significance for this research study, as 'absence' is a hugely valuable diagnostic category. (Bhaskar, 1993 pp. 238-239, 2017)

Bhaskar (1993 p.316) claims that the problems with the current philosophical traditions is the lack of a determinate notion of absence. To quote: 'the principal source of traditional problems of philosophy […] is in each case an ontological absence, and it is, of course, the absence of the concept of absence in the ontology that dialectical critical realism intends to remedy.' (Bhaskar, (1993 p. 316) Bhaskar argues that 'absence' is at the root of all changes. He has assigned 'absence' a real ontological status having causal efficacy.

The concept of absence focuses on change. When we say something changes, it means we are saying something that was there has passed out of existence, or something that was there has come into being. Bhaskar (1993) has used the concept of absence in discussing negation in the sense of the disappearance of what was present, or the appearance of what was not of something new as, he says 'the absenting of constraints on the absenting of absence, or ills' (1993 p. 396).

As Fleetwood (2005) echoes Bhaskar's argument, 'something is real if it is causal, i.e. if it can make a difference to the state of affairs or events, and not simply if it can be seen or empirically experienced'. That is, the absence has been defined in terms of its causal effects, and not just what it is not. The notion of absence is also not merely referring to anything opposite of presence or any process of change. It also does not mean that if I cross the room, I am absenting the distance between myself and the other side of the room. Such simple absenting does not require dialectic critical realism. The notion of absence is significant concerning the 'being-ness' of some object, process, or context, and has a negative evaluative content by reference to the particular being concerned. For example, any wall described as a wall without any pictures on it has not much significance. Nevertheless, an art gallery's blank wall, which could be due to the picture being stolen or removed for any specific reason, e.g. change of ideology of the CEO or the Trust running the gallery, is of significance. Thus, the absence of the picture concerning the art gallery wall is more meaningful, as opposed to a typical wall without pictures.

The notion of absence is also implied in terms of our 'concept of being'. We know natural beings have causal powers, and if these causal powers are actualized, then it is good. Nevertheless, if such beings are not able to actualize their causal powers for whatever reasons, then the significance of absence lies not only in the non-existence of those conditions that make them exercise and actualize their causal powers; but also, in terms of causality, the non-realization of specific powers or potentials. Thus, absence recognises both (a) non-existence and (b) non-realization, e.g., if a drought is due to the absence of rain. The significance of this absence is not simply in terms of the absence of rain. As well as in non-realization of various natural powers, resulting in harm done to various natural beings such as plants, and in animals which die, the land becomes parched and not cultivable, and rivers and lakes dry up.

The verb 'to absent' or 'absenting the absence', is used by Bhaskar (1993 pp. 238, 240) to mean to bring about change by removing something; and this notion of absence is fundamental to conceptualising all change and intentional action. In his words, 'to change is to cause is to absent'. The verb 'to absent' primarily denotes positive evaluation leading to action, which is motivated by an absence, and acts to make present the things which are absent, i.e. to absent its absence.

The concept of absence has massive implications for the emancipation of human beings and for organizations' potential alike, because absenting the constraints would lead to causal powers to be realised and the development of particular causal power for satisfying needs. If a need is not satisfied, then the realization of potentials and powers is not possible.

Table 4-2: Applying selected critical realism concepts for this research study

Critical realism concepts discussed in this chapter	The utility of critical realist concepts for this research study
Stratified reality	Helps to identify the existence of stratification in understanding the circular economy. Informs the investigation to look for empirical traces, structures and causal mechanisms that have led to the current misunderstandings developing about the circular economy.
Causal powers/Generative mechanisms	Allows distinguishing between generative mechanisms and the particular events that they cause in particular circumstances. Helps to identify the possessed, exercised, and actualised powers of the circular economy.
Emergence	Helps to identify which concepts (from those that conceptually mediate) are more closely describe the ideally real circular economy. Allows testing theory in the emergent circumstances, e.g. testing VRIN conditions
Absences and negation	Helps to identify which concepts are absent from the current circular economy discourses. It, in turn, facilitates further investigation to know the reasons for such absences.

Following Cruickshank (2002), the principles of critical realism, in summary, are as follows:

1. An anti-foundational approach to knowledge as it accepts that our knowledge is conceptually mediated.
2. The concept of dependency means it is necessary to examine critically the concepts we use to understand the world.
3. Asking second-order questions about first-order knowledge practices gives us the ability to ask transcendental questions about the possibilities of science.
4. Try to find answers through engaging in an internal critique of the current terms of reference, rather than through foundational principles.
5. Critical realism considers itself fallible; it is a meta-theory, not a prescription.

4.2.1 The reasons for choosing the critical realist tradition over other philosophical traditions for this research study

Positivism and constructivism recognise only a simple dichotomy. Positivism includes objectivist approaches. It is comprised of empirical pieces of evidence and deduction and aligns mainly with quantitative approaches. Constructivism includes subjectivist approaches comprised of interpretivism and induction aligned to qualitative methods. Both positivists and empiricists share critical realists' commitment, that there is an objective world that exists independently of our perceptions/ senses. However, unlike critical realists, empiricists and positivists build laws out of event regularities. They tend to rely on empirical observation of events and generally favour large datasets, and then mine those datasets for statistical regularities and correlations. That is, they look for 'whenever *event type x* occurs, then *event type y* will also occur'. They look for (a) strongly supported propositions to induce from empirical observations, and then (b) test and improve their inductions through experimentation for invariable laws. As a result, they look for dependent and independent variables. For example, if they were to find how many hours a social group typically work in an average week, they would look for a dependent and independent variable. They would identify independent variables such as age, profession, ethnic origin, gender, number of children, their location, and so on, as this would influence the number of hours spent at work. They would then look for statistically significant relationships and, once confirmed, they would generate law(s) to describe the regularities observed, which are universally applicable. What this method essentially means is, the assumption emerges from methods that consider the mathematical relationship to be a reflection of the social world, which is similar to a 'closed system', as in a laboratory environment where experiments with numerical data are conducted by isolating and studying the independently specific phenomena. Empiricists and positivists limit the objective world to empirical ‘facts’, i.e. things that are observable. They quantify these empirical facts and try to observe regularities in events, and through correlation, generate universal statements, thereby developing ‘laws’ about the world. Such empirical ontology does not recognise the other facets of the world for which no observations are possible (Mingers, 1984; Blaikie, 1993 p. 14; Mingers, 2014).

Critical realists disregard such reifications arising out of correlations as they argue that we cannot separate the independent role(s) of broader context(s) in a phenomenon arbitrarily. Hence, they consider the accounts produced by empiricists and positivists to be ‘thin accounts’. They say it can only describe but cannot explain empirical events of a phenomenon. For example, positivists might correlate performance-related pay (PRP) to the better overall performance of the organization. However, they fail to explain the mechanisms which may or may not explain how these two phenomena relate to each other (Hesketh and Fleetwood, 2016). For critical realists, there could be several ‘knowable’ reasons why PRP needs correlation with higher-performing firms, which have little or nothing to do with performance caused by PRP schemes. The reasons could be that wealthier firms can afford to have such schemes or that triggering of PRP and higher performance could be by a third factor (proactive senior management).

In contrast, these reasons do not have a direct relationship with a performance at all. Critical realists contend that positivists and the deductive approach are not capable of eliciting such an explanation. They believe the social world is not a closed system such as a laboratory, but open to a complex array of influences, which often change in unexpected ways both temporally and geographically.

For a subjectivist or a constructionist reality exists within texts and discourses. For them, there is ‘no external reality’ outside this domain. They argue that knowledge is entirely discursive and, as a result, inherently ‘unstable, fragmented and susceptible to frequent rewriting’ (Webb, 2004 p. 724). Thus, it means knowledge is gained through exploring and reinterpreting subjective meanings primarily driven by identification of discourses and their construction of meanings. For the critical constructionist, the generation of the truth of ‘whatever exists’ is determined by Orwellian hegemony established through dominance (Willmott, 1993). Ironically, this implies that they even generalise the properties and relations of discourses, identities, and reflexivity (O’Mahoney, 2011).

Critical realists are conscious of such political natures of constructivism and therefore, sceptical of its truth claims. ‘Objective-knowledge’ best describes this scepticism because once an ‘objective-knowledge’ is out of its community it quickly comes to acquire a substantively different meaning. It often makes claims to objectivity ambiguous because such objective-knowledge is at risk of reinterpretation across different social domains. For example, a manager's access to, and claims for, superior knowledge, are often justified as the basis for political decision-making in which the interests of business owners and managers gain priority over other groups in the organisation. Both critical realists and constructivists agree that claims to objectivity and truthfulness are compromised and can have negative consequences, and depend upon the vested interests of those who have superior knowledge, and on circumstances.

Conclusively, the critical realism tradition is committed to differentiating between real, actual, and empirical levels of reality. It keeps ontology and epistemology separate. Critical realism assigns explanatory powers and clarity to this research study for distinguishing between entities, structures, and causal mechanisms; and between possessed, exercised, or actualized powers of the circular economy. Critical realism also helps to identify emergence and absences required for facilitating a uniform understanding of the circular economy across all sectors. Accordingly, it first establishes the circular economy to be a transitive object, which is not 'ideally real'. Such analytical segregation is critical for studying the circular economy paradigm, not only for removing prevailing confusions in its understanding, but for also how firms use their resource base. The causal powers that establish the being-ness of a circular economy would explain its real possessed, exercised and actualised/ un-actualised powers. In turn, it would help firms not only in securing their future cash flows by decoupling economic growth from resources consumption, but also in ensuring environmental protection and societal benefits. Critical realism also offers a critical approach, which not only accepts that beliefs can be false, but that the identification and retardation of those mechanisms that create false beliefs can contribute to emancipation. Thus, critical realism presents the circular economy paradigm powers that encompass wellbeing for current and future generations.

4.3 Research Design

Sayer (1992) contends that a researcher's philosophical position sets the grounds of research and defines methodological choices. He suggests taking a carefully considered approach for understanding the different facets of the social world that the researcher is investigating. He advises that while making a judgement about methods, it is pertinent to consider our research enquiry as a triangle whose three corners are a method, object, and purpose; and to consider each corner vis-à-vis the other two. In other words, the object of enquiry decides the method and techniques of enquiry.

From Sayer's perspective, the aim, objectives, and research questions are laid out again for a quick recall for the reader.

This research study aims to investigate the circular economy and how it impacts on UK manufacturing firms and government agencies. How do they understand, construct and operationalise a circular economy for achieving competitive advantage? It also assesses whether the RBV's VRIN framework is suitable for a firm participating in the circular economy.

The objectives, therefore, are (a) exploring the nature of the circular economy, and (b) investigating its impact on firms' resources for achieving competitive advantage, and policymaking.

The research questions that help to address the aim and objectives of this research are:

RQ1: What best describes the current understanding, construction, and operationalisation of the circular economy by UK manufacturing firms, and government agencies?

RQ2: How do firms manage waste?

RQ3: How does the understanding of the circular economy affect the characteristics of the resources required for achieving a competitive advantage within circular economy environments?

RQ4: What are the policy implications of the circular economy influencing the use of resources?

Accordingly, a qualitative comparative case study approach would help investigate what the circular economy means to businesses and government agencies and how they operationalise it to achieve a competitive advantage. Besides, this would also allow for testing the validity of VRIN conditions in the context of the next generation competition. This study shall use the working definition developed in chapter 3 and the conceptual framework presented in figure 3-

2. To investigate the research focus (the portion marked in red in figure 3-2 presented in Chapter 3, the author follows Ackroyd and Karlsson (2014) in selecting the research from the eight distinctive research designs (for the overall strategy of research) having the abductive and retroductive logic of discovery presented in Table 4-3 below:

Table 4-3: Eight designs relevant to realist-informed research and some of their characteristics. Adapted from Ackroyd and Karlsson (2014 p. 27).

Research procedures	Distinctive research strategies			
	Intensive ←		→Extensive	
	What is the mechanism? (Context as given)	How do context and mechanisms		What is the context?
		Typically-interact?	*Historically-interact?*	Mechanisms inferred
Detached study	Case studies	***Comparative case analysis***	Generative institutional analysis	Research surveys and census data
Engaged study	Action research	***Intensive realist evaluation***	Barefoot historical research	Extensive realist evaluation
The dominant logic of discovery	Abduction	***Abduction/Retroduction***	Abduction/Retroduction	Abduction/Retroduction

Based upon the seven steps that resulted from the conceptual framework detailed in chapter 3, the author chooses a comparative case study from table 4-3 above, focusing on how structures and mechanisms typically unfold in a particular context. Since the aim, objectives, and research questions demand looking very carefully for what managers say and do in practice, in the context of a circular economy. The author uses abduction as it allows a systematic combining, using both induction and deduction logic for developing the most plausible explanation of a phenomenon based on an incomplete set of facts (Dubios and Gadde, 2002).

The choice of comparing cases is consistent with Sayer (1992, 2004) as he identifies cases to be the suitable vehicles to examine causations, allowing us to place equal emphasis on contexts and causation, thereby helping to generate more nuanced explanations of managerial actions and organisational drives. Kessler and Bach (2014) also favour comparing cases, arguing that it allows the understanding of emergent outcomes and generative mechanisms, thereby helping to explain causalities and emergences better. The case study and comparing cases is also consistent with Yin's (, 2018 p.15) claim that 'case study is an empirical method that (a) investigates a contemporary phenomenon ('the case') in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be obviously evident'.

Many authors such as Eisenhardt (1989a), Miles and Huberman (1994), Robson (2002), Yin and Davis (2007, Spring), Bryman (2012), and Yin (2009, 2018), have explained the ways and means to make case study research rigorous. They recommend that it is always better to explain how the research investigation addresses internal and external validity, including explaining how reliable the research study is.

Yin (2018.p.45) says internal validity is essential, especially when the investigator is trying to explain causal effects such as how *event x* led to *event y*. He suggests keeping in mind that there could be some third *event z* that may have caused *event x.* Yin is primarily pointing towards considering non-observable events which could explain causation. This research study also follows the same logic based upon the critical realism premise. That is, there is an objective reality beyond our perception/ senses. It rejects regularities that positivists or empiricists usually follow. It encourages looking for clues by going beyond the empirical domain to explain causation, e.g., understanding the behaviour of ants to find the disappearance of stones from the garden. That is, a critical realist is not satisfied by inferences based upon regularities, such as, if *event type x* happens then *event type y* happens. As a result, internal validity is inbuilt within critical realist research, and this study is not an exception. However, as a concept, internal validity does not fit critical realist research because it conflates the empirical traces with the event and the event with the mechanisms. Similarly, the concept of external validity is not fit for critical realist research because it draws on the empiricist tradition. Critical realist research presents an impoverished account of reality (Johnston and Smith, 2008).

- ***Use of comparative case study approach***

Comparing a particular context across several different cases adds value to qualitative case study research as it allows for identifying broader tendencies, demi-regularities, and underlying causal mechanisms, locating them at appropriate places (Kessler and Bach, 2014). It is similar to carrying out several experiments on a particular topic and is consistent with both non-critical realist research (Yin, 2018), and critical realist study (Ackroyd and Karlsson, 2014).

    - *Case and the unit of analysis*

Grünbaum (2007) informs about the conceptual ambiguities in determining a 'case' and 'the unit of analysis.' For example, Patton (2002 p. 447) argues that 'Cases are unit of analysis', i.e., there is no distinction between the case and the unit of analysis. Similarly, Feagin et al. (1991 p. 36) consider the unit of analysis identical with the meaning of a case study. Vaughan (1992) argues that the case can be everything, hence similar to the 'unit of analysis'. Miles and Huberman (1994 p. 25) state that 'the case is, in effect, your unit of analysis'. Yin (2003) the most influential contributor, is also not explicit in explaining the distinction between a case and the unit of analysis.

Grünbaum (2007 p. 85) locates the ambiguities by citing examples from Yin's different editions. He states that:

> 'Yin argues that the unit of analysis is identical to the case itself '(Yin, 2003 pp. 22-26). Yin puts forth that, 'this third component is related to the fundamental problem of defining what the 'case' is….' He then refers to Platt's (1992a, b) articles in which the case and the unit of analysis are identical. Yin argues, that 'in each situation, an individual, a person is a case being the study, and the individual is the primary unit of analysis' (Yin, 2003 p. 22)'. In the 1994 (p. 44) edition, Yin states 'unit of analysis (or the case itself)'. Similarly, in the sixth edition, Yin (2018 p. 102) argues 'the common distortion begins because the data collection sources may be individual (e.g., interviews with individuals), whereas your unit of analysis ('the case') may be collective (e.g., the organization to which the individual belongs).'

These conceptual ambiguities necessitate an understanding of how a unit of analysis can be understood and how it can be identified in each study to build an authentic/credible and transferable/fitting case study results.

Many authors such as Easton (1994, 1995, 2010); Yin (2003, 2009, 2011, 2018); Patton and Appelbaum (2003); Healy and Perry (2000); Tsoukas (1989) have argued that the case study should be regarded as a research methodology. Grünbaum (2007 p. 88) argues that ambiguities mostly pertain when the case study is utilized as a research methodology. So far, not much attention has been paid towards a conceptual separation of a case from the unit of analysis. However, Ragin and Becker (1992) and Bonoma (1985) have tried to explain what a case, but their explanation is independent of the unit of analysis. Grünbaum (2007 pp. 85) points to the logical inconsistency in Yin's frequently cited four types of designs for case studies mentioned in his different editions (e.g., Yin, 2003 pp. 22-26; Yin, 2018 pp. 48 and 102), presented in figure 4-1 below. He argues that Yin's two-dimensional typology has the number of the cases on the horizontal axis, whereas, on the vertical axis it has both type of cases (i.e., holism versus embedded) and the unit of analysis, i.e., two constructs on one axis at the same time. He offers an alternative conception of the unit of analysis and a case to remedy this inconsistency.

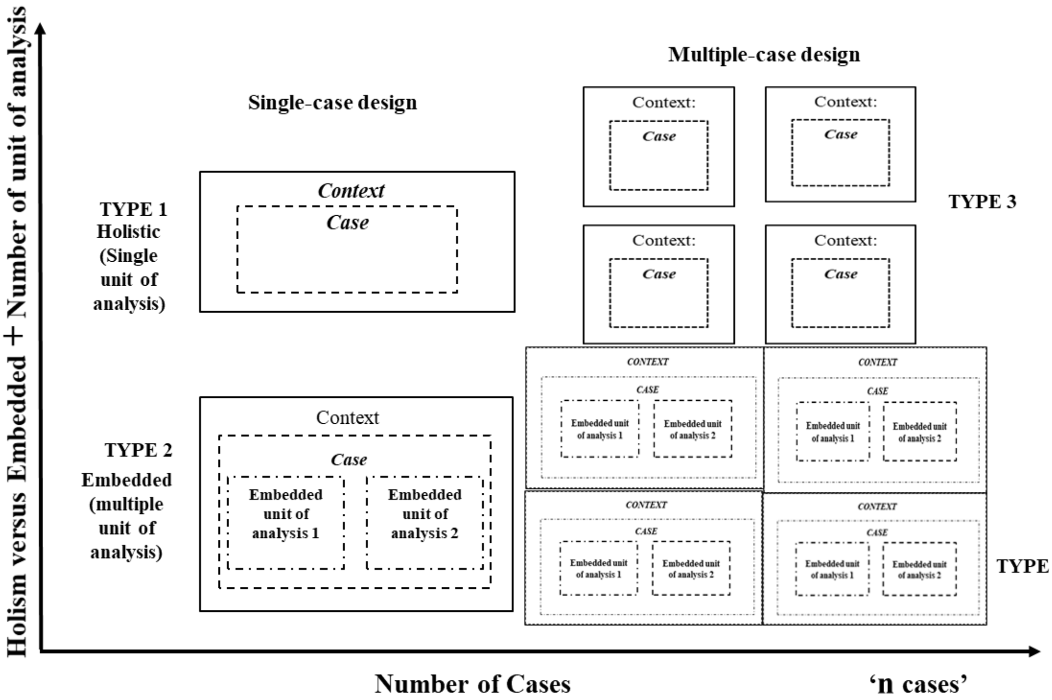

Figure 4-1:Basic types of designs for case studies Yin (2018 p. 84)

Grünbaum (2007 pp. 88-89) argues that a case can be divided into layers surround the unit of analysis, or 'the heart' of the case, presented in figure 4-2 below.

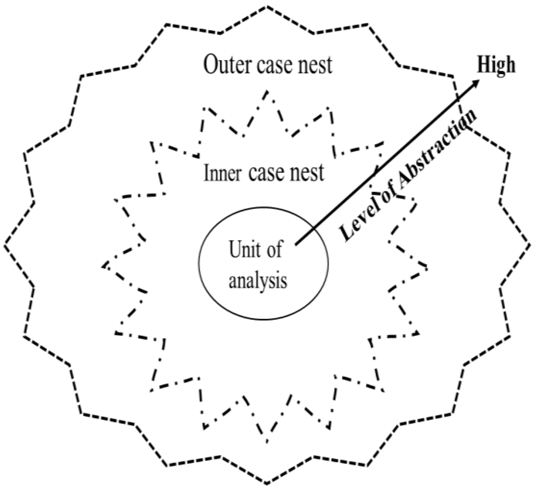

Figure 4-2: A conceptual understanding of a case and the unit of analysis. Source (Grünbaum, 2007 p. 89)

In the above concentrically layered case typology, the unit of analysis is placed on a 'lower level of abstraction than the case layers and constitutes specific information about the unknown that the research wants to enlighten. Figure 4-2 shows the elaborated relationship between the unit of analysis and case layers where the unit of analysis constitutes the micro-level, and the case represents something close and logically connected to the unit of analysis. Each case layer is assumed to be on a higher level of abstraction than the previous, and each case layer is unique and holistic. Figure 4-2 can be understood as an abstraction ladder that the researcher can move meaningfully from one to another when trying to see the broader impact on the unit of analysis and advance and refine case results. The idea and logic of a ladder of abstraction enhance empirical data's vital transformation into novel explanatory knowledge. The concentric layers of cases with the unit of analysis at the centre is much simpler to understand.

According to Patton (2002 p. 229)

> 'The key issue in selecting and making decisions about the appropriate unit of analysis is to decide what you want to be able to say something about at the end of the study.'

Many scholars such as Berg (2001 p. 231); Patton (2002 pp. 228-230); Yin (2003 pp. 22-26); Grünbaum (2007 p. 88) consider identifying the unit of analysis is a must because it intensifies the purpose of the study. For them, a unit of analysis is the central concept connected with the understanding, preparing, and implementing a case study and it could be (a) an individual (b) a group (c) an organisation (d) a geographical unit (regions, towns, census, state) (e) social interactions (dyadic relations, divorces, arrests).

The unit of analysis intensifies the purpose of the study (aim) does not mean that one can be reduced to another. There is a distinction between the purpose of the study (aim) and the unit of analysis. For example, the research purpose leads to a need for more information (e.g., conducting a literature review to identify the gap, then articulating a meaningful problem, and then formulating a research design to find answers to the problem). The information can be found among specific individuals, for example, individuals in an organisation or a classroom, or a service centre. The unit of analysis can be identified through particular individuals (i.e., key informants (John and Reve, 1982 p. 519); (Bansal and Roth, 2000 p. 721)) that are purposefully selected because they possess knowledge that can shed light on the problem at hand. It means the unit of analysis is determined to be individuals and or actions of individuals or their lived experiences. In other words, the unit of analysis is identical to the knowledge that the key informant can provide to the researcher. Thus, the information thus gathered will represent the ground reality and connect closely to the research purpose. Such information would allow data analysis, which, in turn, would facilitate authentic knowledge generation.

Grünbaum's (2007) conceptualisation of the concentric layers of the unit of analysis and a case fits this critical realist research study because it allows probing and digging deep into the different layers of cases to identify interconnections, and in turn, the 'whole circular economy' or the 'ideally real circular economy'. It also enables the author to move from one ladder to another to go beyond in search for intricate details in play to build explanations. It is also consistent with the case study method for critical realist research advocated by many critical realist scholars such as Easton (2010); Ryan et al. (2012); Wynn and Williams (2012); Mingers et al. (2013); Ackroyd and Karlsson (2014) and others.

- ***The cases and unit of analysis for this research study***

Yin (2018) suggested that having two or more cases will ‘produce and even stronger effect’, blunting the criticism and scepticism about the researcher’s ability to do empirical work beyond a single case. He is in favour of selecting trials for replication. He tells us that this may seem analogous to multiple ‘experiments’ with examples chosen either to ‘predict similar results (literal replication) or predict different outcomes for likely reason (theoretical replication)’. Eisenhardt (1989a) suggests three mutually exclusive rationales for multiple case selection. These are: (a) to replicate cases, (b) to extend emergent theories and (c) to fill theoretical categories. Kessler and Bach (2014) argue that both these authors are conflating the issue - Eisenhardt is implicitly ruling out the possibility of a new emergent theory, whereas Yin (2018) makes a false distinction between literal and theoretical replications. Kessler (ibid) contends that if an expectation of different outcomes requires an *a priori* explanation, then the anticipation of a similar outcome may also need an *a priori* explanation. However, both Eisenhardt and Yin support the critical realist perspective as both their views focus on revealing patterns and their underlying causation.

Following on from Grünbaum (2007), Yin (2003, 2009, 2011, 2018), Eisenhardt (1989a), Ackroyd and Karlsson (2014)and Kessler and Bach (2014) the author believe comparing a set of diverse group of firms and government agencies would help to answer the research questions and help in digging deep to find the most plausible explanation for the understanding of the circular economy.

The value of comparing cases depends not only the careful selection of evidence but also on the selection criteria (Easton, 2010). Therefore, the overarching principle for selecting firms for this research study are to identify manufacturing firms dependent upon mined raw material resources and are sensitive to resource price fluctuations. It results from Eisenhardt (1989a) suggestion not to randomly select cases, and Miles and Huberman (1994) and Yin’s (2009) assertion for taking a direct approach while selecting cases.

As a result, the author identifies groups of automotive and IT firms from UK manufacturing and government agencies and its devolved governments including the European regions. Since the automotive and IT firms operationalises the circular economy they are considered as the 'inner case nest'. Whereas the government agencies do not operationalise a circular economy but are representatives of the policy environment in which the automotive and IT firms are located, therefore, they represent the external environment, hence, they are considered as 'outer case nest' (Grünbaum, 2007), represented in the figure 4-3 below.

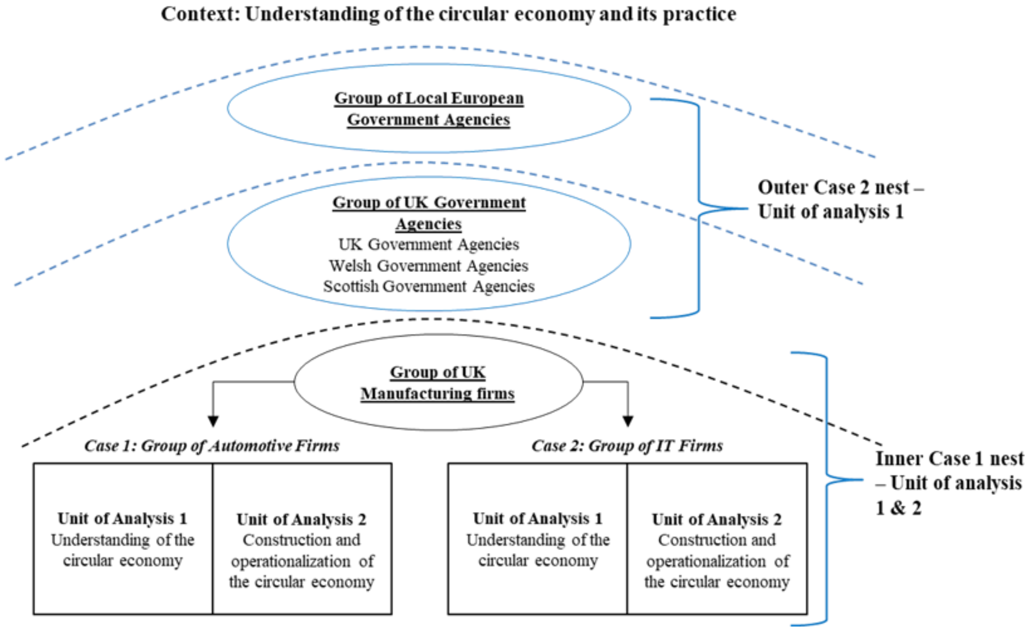

Figure 4-3: Schematic representation of the comparative case design Source: Author (2020) - Adapted from Grünbaum (2007), Eisenhardt (1989a) and Yin (2003, 2009, 2018)

Figure 4-3 above can be explained as follows. In this study, the three cases are (1) the group of UK automotive firms (2) the group of UK IT firms – these two forms the inner case nest, and (2) the group of government agencies –it forms outer case nest. Each group is made up of different types of automotive and IT firms and government agencies. The unit of analysis is the firm. The government agencies/departments are considered as an equivalent of the firm. The unit of analysis, i.e., the firm, is investigated in two contexts –(a) understanding of the circular economy and (b) the construction and operationalisation according to the firm's understanding of the circular economy. Data (information) is collected through individuals who work for the firms and are the key informants shedding light on the understanding of the circular economy through their lived experiences (John and Reve, 1982 p. 519); (Bansal and Roth, 2000 p. 721)). The approach is consistent with the critical realists' conception of the world. The world for them is a series of nested levels from the microbe to society's broader social system. Each of these levels has entities having powers and modes of reproduction, which are particular to that level and serve as the ground to produce a higher level. The higher level, therefore, emerges from the lower levels in the hierarchy (e.g., the brain emerging from the body; mind from the brain, and consciousness from the mind – each is independent and irreducible to the other (Hinds and Dickson, 2021) – also, to find the appearance of stones from the garden one must know the behaviour of the ants (Ackroyd and Karlsson, 2014)

The reasons for choosing UK automotive firms are that it is one of the oldest, most technically advanced British heritage manufacturing. The automotive firms are also hugely dependent upon mined raw material resources and get severely affected by a slight fluctuation in their prices (EEF, 2014, 2015). Further, the automotive manufacturing is strategic for the UK economy as it employs about 900,000 people and brings in around £49bn in tax receipts every year even at a time of crises such as Brexit and COVID-19 (SMMT, 2017, 2019; Bailey, 2020).

Similarly, the Information Technology (IT) is another large UK manufacturing, considered the backbone of many industries. It consumes rare-earth raw materials that the European Commission has declared critical raw materials (European Commission, 2014, 2015b; Delgado et al., 2016; European Commission, 2017c, 2018). Both the automotive and IT firms form the 'inner case nest'.

The UK government, the devolved government of Wales and Scotland, and the local European government agencies responsible for policymaking and maintaining natural raw material resources and protecting the environment form the 'outer case nest'. The inclusion of the local European government agencies stems from the fact that (a) the European Commission is ahead of the curve in promoting the circular economy and (b) the front-line UK Government agencies such as DEFRA follows the guidelines set out by the European Commission for the circular economy. Hence, the author thought it is worthwhile to probe local European government agencies to understand if any lessons can be learnt from them regarding the understanding of the circular economy.

Locke and Thelen (1995 p. 27) suggest isolating and exploring a single process for selecting-to-difference and finding similarities. They argue that such contextualised comparisons provide a different angle to issues and yield insights that would otherwise not be possible. Therefore, following Locke and Thelen (1995), and Grünbaum (2007), the author investigates two units of analyses in two contexts, i.e., (a) firm's understanding of the circular economy and (b) how they operationalise a circular economy as per their understanding. The second context links to the red demarcated area in figure 3-2 in Chapter 3 and consists of two processes. Firstly, the manager's ability to understand resources functionality and exploit any residual ability of a resource. Secondly, combine and recombine wastes with virgin raw material resources for generating additional productive services from resources. Again, following Locke and Thelen's (1995 p. 27) suggestion this research focuses on the second process, i.e., the firm's ability to combine and recombine waste with virgin raw material resources for generating additional productive services.

These capabilities are similar to Barney's description of a manager's resource picking skills from strategic resources markets; and the sensing, seizing, and reconfiguring of Teece. Both these processes contribute to a firm's superior performance and are potential areas to look for causation and emergence. It would also help to verify if a circular economy is a dynamic capability that this research proposes in its working definition in Chapter 3. This is consistent with Eisenhardt's (1989a) and Yin's (2009) advocacy about light theorising, explained earlier. The author was convinced to compare cases for differences and similarities consistent with Yin (2009, 2018) and Kessler and Bach (2014) because it reveals patterns and their underlying causation.

However, Bryman (2012) raises the concern that such purposeful case selection raises practical issues, not least being research access issues. This concern has turned out to be true for the author/ researcher.

- ***Sample Organizations***

The above case design has three cases and five groups represented in the figure 4-3 below.

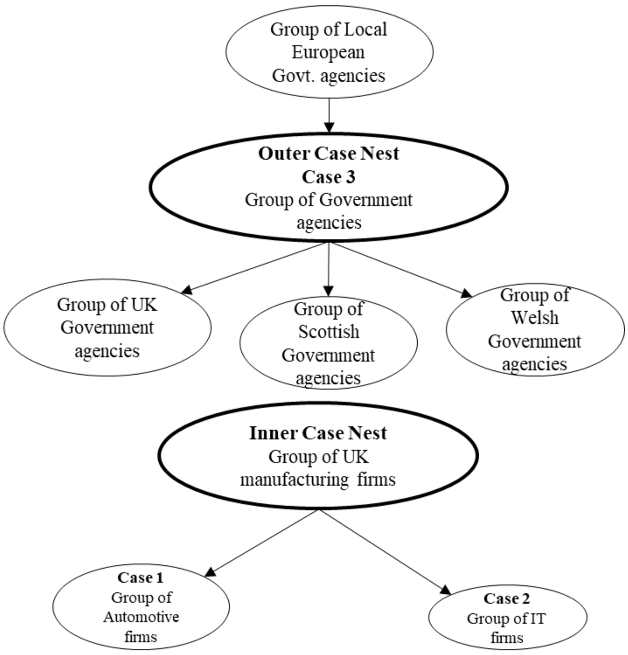

Figure 4-4: The cases and groups in this research study

- ***Case 1 - The recruitment of firms in the inner case nests***

Participant recruitment was a lengthy process, taking about 14-15 months. However, the sample size of thirty firms (including government agencies across both inner and outer case nests) have a total of thirty-four participants. It is a right mix and well- balanced sample size, consistent with

Creswell (2013) and Adler and Adler in (Baker and Edwards, 2012), evidenced in Table 4-4 below:

Table 4-4: The number of participating firms in the inner and outer case nests.

The Inner Case Nest – UK Manufacturing Firms		
	Firms in each group	Number participants in each group
Automotive	11	11
IT	08	08
The Outer Case Nest – UK and European Government Agencies		
All Government Agencies	11	15
Total	30	34

The author adopted a multi-pronged approach to addressing the issues with access to the automotive and IT Original Equipment Manufacturers (OEMs). The first step was removing the limiting criteria that previously allowed for the inclusion of only those OEMs whose production processes relied on natural raw material resources. The second step was to expand the selection criteria to include OEM supplier firms (including tier one and tier two component manufacturers), trade associations, private/ technical consultants, and professional technical consultancies. These two steps facilitated recruiting most of the key players across the automotive and IT firm's value chain, thus expanding the sample bouquet. It provided a holistic approach, while enabling opportunities for fruitful comparisons of similarities and dissimilarities between a wide range of companies, about their understandings of the circular economy, from across the three groups of firms/agencies.

The third step, not linked with the previous two, is the author undertaking training. The author participated in an ESRC-sponsored DTC Advanced Training workshop on 'Communication skills in projects involving direct contact between researchers and participants'; conducted by GPs to help clinicians recruit research participants for clinical studies. The learning for the author from this workshop is: '*go to places where you will find them'*. This learning helped the author to include a filter process for recruiting participating firms. That is, an identification phase ensued from this learning, which included the author participating in a variety of industry events, seminars, technical theatres, and keynote industry updates held as part of industry exhibitions, round-table discussions, and policy debates in the UK Parliament. The basis of the identification process depended upon:

a) The size of the firm based on FTSE 100-500 rankings.

b) Evidence(s) of the firm following some or all processes as informed by the literature, and firms following waste management/ environmental policy or being involved in CO_2

reduction or GHG emissions. Alternatively, a company branding itself as a 'green' company.

c) Evidence of pioneering processes or an industry leader or a power influencer.

d) A company's voluntary interests in the circular economy, or alternatively, if its activities are aligned to a circular economy thinking.

With these identification criteria in the background, the author participated in several events[28](see Appendix 2), often using judgemental rationality for attendance. These attendances resulted in the author gaining the insight that 'resources' and 'managerial capabilities' are central to the circular economy, which reaffirmed as appropriate the selection of RBV theory and dynamic capabilities for providing a theoretical lens to investigate the circular economy within UK manufacturing.

Before attending any trade exhibition or a trade show, the first thing the author did was to get hold of the show guide. From the show guide, the author gathered information about the exhibitor profile, which helped in deciding the stalls to visit in the different pavilions. As they were trade shows, firm's representatives openly shared information about the names and the designations of senior management and gave some idea about the firm's approach to environmental issues. These conversations gave the author an overall understanding of the relevance of the firm for this research study.

After attending any event, the author sent an invitation letter to the previously identified member, or to a member of the senior management team, inviting them to participate in the research study. The details of the research study were mentioned in the invitation letter, explaining how the company would benefit from this research study. The author repeated this process after attending any event, which included seminars, or breakfast briefing/ dinner meetings at the House of Commons in the UK Parliament, or keynote speaker/ technical talks, events, seminars, or workshops.

- ***Details of participating automotive group of firms***

Only firms making a difference in the context of this research study were included for study. It is consistent with Yin (2009, 2018) and Miles and Huberman's (1994) suggestions that group(s) at a firm-level need to be defined in terms of a context.

[28] The list of the Circular Economy events that the Author attended is available in Appendix 2.

Table 4-5 below give details of the selected eleven participating automotive firms. The break-up of eleven participating firms was (a) three OEMs -original equipment manufacturers, (b) three remanufacturers, (c) three recyclers, and (d) one material consultant, plus (e) the flagship

automotive trade association. Each participant/ firm is individually analysed to explore their understanding of the circular economy and how they use their base of raw material resources.

Table 4-5: Details of the firms in the automotive group

Details of the automotive group firms	Main Business Activity
Original Equipment Manufacturers	1. Premium car manufacturer
	2. Fuel efficient car manufacturer
	3. The Hydrogen fuel car manufacturer
Recyclers	4. Aluminium Metal Recycler
	5. Ferrous and Non-Ferrous Metal Recycler
	6. Polymers/Plastics Recycler
Remanufacturers	7. Electronic component remanufacturer
	8. Mechanical component remanufacturer
	9. Waste-Heat recovery batteries manufacturer
Material Consultant	10. Material Consultant
Trade Association	11. Automotive Trade Association

The OEM group included three firms, viz., a premium car manufacturer, a fuel-efficient car manufacturer and an innovator. The recyclers group of firms is further subdivided into metals, non-metals, and polymers recyclers. Similarly, the remanufacturers group included electronic and mechanical component remanufacturers, including a waste heat recovery firm. These representations facilitate an in-depth investigation and ensure rich data.

- ***Details of the participating IT group of firms***

Eight firms in the IT group were recruited, as described below in Table 4-6. The break-up of eight firms is as follows: two computer manufacturing firms from the laptop, desktop, and printer segment; two firms from telecommunications; one 3D printer manufacturer; one digital automation arm of the world's largest technology company; one software development company; and one Technology companies flagship trade association.

Table 4-6: Details of the firms in the IT Group

Details of the IT Group firms	Main Business Activity
Original Equipment Manufacturer (OEMs)	1. IT managed services provider
	2. IT infrastructure services provider
Telecommunications	3. Telecommunication service provider
	4. Telecommunication equipment manufacturer
Additive manufacturing services	5. 3D printing machine manufacturer
Factory Automation/ Digitalisation	6. Digitalisation Services Provider
Software Development	7. Software Developer
Trade Association	8. IT Industry Trade Association

- ***Case 2- The recruitment of Government agencies in the outer case nest***

Eleven government departments/ agencies took part from England, Wales, and Scotland, the Netherlands, and Croatia. Table 4-7 lists all the government agencies and their participants interviewed. The participants from the Netherlands and Croatia were also part of the SCREEN[29] workshop organised by Innovate UK. Fifteen participants who were directly involved with the circular economy initiatives were approached. All of them voluntarily agreed to take part in this research study.

[29] SCREEN – Synergy. The circular economy across European Regions Event held on 21.11.2017 in London.

Table 4-7: Details of participating government agencies

The Outer Case Nest Case 3	
Government's Nodal Agency	**Main Business Activity**
DEFRA – Department of Environmental Food and Rural Affairs	1. Strategy development: The circular economy and resource efficiency 2. Materials and Wastes Evidence Team 3. Economist – Producer' responsibility
The Innovate UK	4. Manufacturing and Materials Innovation
WRAP – The Waste and Resource Action Programme	5. The Circular Economy leader 6. The Circular Economy in the Textiles industry
LWARB – The London Waste and Recycling Board	7. The Circular Economy champion
Environment Agency	8. Waste and Planning Strategy Division
Zero Waste Scotland	9. Resources Management Division 10. The Circular Economy Business Support Division
Welsh Government	11. Water and Wastes Resource Efficiency Division
Birmingham City Council	12. Business Enterprise and Innovation Support Division
Local Partnerships	13. Wastes sector Projects Division
European Region – The Netherlands	14. The Circular Economy Strategy Division
European Region - Croatia	15. The Circular Economy Promotion Division

- ***The participants detail***

Yin (2018 p. 102) stresses the common distortion that may arise when the data collection sources may be individual people (e.g., interviews with individuals as it is in this study), whereas the unit of analysis is the firm. He says, 'even though your data collection may have to rely heavily on information from individuals, your conclusions cannot be based on entirely on the interviews as a source of information' (Yin, 2018 p. 102). The author was conscious about this distortion hence he adopted the triangulation of data and developed the most plausible explanation of the understanding of the circular economy through a systematic combining of both inductive and deductive logic explained in more details while discussing how data was analysed – explained in next sub-section.

Initially, while designing research, the author planned to recruit about thirty-five interviewees from different hierarchies from the firms/government agencies, such as (a) Board members, (b) middle to senior management from all relevant departments, and (c) shop-floor employees, to get an idea of whether the understanding of a circular economy is uniform across all levels.

The decision to limit interviews to thirty-five took into consideration the views of various academics about how many interviews were enough to give a robust result. For example, according to Yin (2009), the number of interviews should not be fixed before; instead, the researchers should focus on getting information on different aspects of the object of enquiry. Whereas Creswell (2013) suggests the sample size be between five and twenty-five; while Adler and Adler in Baker and Edwards (2012 p. 5) suggest the sample size to be 'between twelve and sixty with thirty being the mean'. It resulted in selecting thirty-four interviewees from thirty firms across all the three cases.

However, practical experiences in the field were different. Since most of the recruits were from among those giving talks on the circular economy topic at trade events or participating as a member in 'Industry and Parliament Trust' events held at the House of Commons, they were mostly senior managers. When the researcher spoke to such individuals, he learnt that these senior managers themselves were grappling with the circular economy concepts. It led to (a) dropping the shop floor employees from the list but keeping the option open to include them on a need basis, (b) making the researcher aware of expected biases in responses, and (c) to look for the influences in response while coding - this 'influence issue' has been pointed by different scholars as examined in the circular economy literature review. The researcher also came across a few gatekeepers, particularly of those firms that claim to implement the circular economy, blocking the researcher from speaking to other members within the firm.

The above recruitment process might seem to be a convenient sampling, but this is not the case. In most cases, the researcher approached the participants only after listening to their talks at an event. Whereas, in other cases, the author identified participants from the attendees' list of events/ seminars/ workshops that were either directly related to the circular economy or dealing with resources or technology development.

The author followed all recruitment protocols for recruiting participants. That is, participants were formally approached through an introductory email/letter[30] citing the event at which they met the author. After that, before the interview, the author ensured that the participant signed the consent form[31] and read the information sheet[32]. The author read out the confidentiality clause and Aston University's ethics for the participant's information, to gain their confidence. The author also made it clear to the participants that in the event of the use of any of participant's quotes for any publication(s), he would seek prior written permission. Before proceeding with the interview, the author explained that there is no coercion in any manner whatsoever and

[30] See Appendix 9
[31] See Appendix 10
[32] See Appendix 11

reassured the participant that the conversation would be confidential, and he/ she shall maintain anonymity. Finally, they were asked if they were happy to proceed with the interview. Only upon getting an affirmative answer did the author proceed with asking questions. Such reassurances helped the author to win the participants' confidence, which was much needed to draw out the structures and mechanisms in play.

- ***Data collection: Use of semi-structured interviews and observations***

Robson (2002 p. 271) quotes King's (1994) words 'qualitative research interview is most appropriate where a study focuses on the meaning of particular phenomenon to the participants', and 'to gather descriptions of the life world of the interviewee'. According to Sayer (1992), the use of semi-structured interviews, as well as observation, are appropriate considering the difficulties in investigating multi-dimensional and complex paradigms such as the circular economy. The discussions followed an interview guide informed by the research questions and conceptual framework, as in figure 3-2 in Chapter 3 mentioned above.

However, before developing the interview guide, the author piloted three semi-structured interviews with (a) an Aluminium Federation representative, (b) a fellow academic, and (c) a non-industry person, to evaluate whether the words used in the interview guide were appropriate and thoroughly understood, and to ensure that there was no gap between the terms used and the participants' understanding. This exercise helped to reduce confusing words from the interview guide and ask about one issue per question.

As a result, the author was able to conduct thirty-four semi-structured interviews in a free-flowing conversational mode. On average, each meeting lasted about 45-70 minutes with one or two exceptions lasting for about 90 minutes. Some of the participants shared a lot of their lived experiences/worldview in depth, compared to others. The author used probing and leading questions to the participants, wherever appropriate digging for rich lived experiences, justifying the choice of semi-structured interviews.

After each interview, the author made notes of the significant observations that the participant made during the conversation. For example, overall comfort in answering the questions, expressions, voice modulations, if the participant was saying something but meaning something else, or did the participant mention one thing more than others during the conversation.

While interviewing, the author attempted to include all possible influences on the understanding of the circular economy. The author listened intently to the responses provided and requested the participant to repeat when necessary in order for the author to check he had understood what the participant meant.

The author usually started the interview inquiring about the participant's role, responsibilities, and academic background, although these ice-breaking questions depended upon the circumstances. A sample of the complete questionnaire for semi-structured interviews is available for review in Appendix 12.

At the end of the interview, the author requested a follow-up meeting, to which almost all participants agreed. The author's conversation with the participants did not follow a fixed pattern as the research questions listed above or semi-structured interview questions presented in Appendix 12. However, instead, these questions were used as prompts, guiding items similar to a doctor enquiring a patient while diagnosing, looking for pieces of evidence and patterns in occurrences. In critical realism, the enquiry encompasses underlying mechanisms in varying contexts and outcomes (Pawson and Tilly, 1997).

Following Yin (2009), the author collected pieces of evidence from other sources such as firms' sustainability reports, annual reports, and office artefacts. The author also requested of participants whether it was possible to get access to their firm's waste management policy or guidelines that they issued to their suppliers. A few participants willingly shared their corporate social responsibility (CSR) documents and purchasing instructions, while others did not, citing it as a confidential document, which cannot be shared with members of the public.

Later the author triangulated all data sources, i.e., observations with audio transcriptions and secondary data (sustainability reports and waste management policy document if available), leading to findings and analysing of data for answering the research questions.

- ***Equipment used for data collection and transcribing the audio recordings***

There was no specialised material or equipment required for data collection, except everyday things such as pen, pencil, dairy, and Dictaphone, and, needless to mention, a laptop, which is a piece of essential equipment currently necessary for any research activity.

The author used a professional SONY brand hand-held Dictaphone, having wide-stereo recording capabilities and built-in speaker and an S-microphone system that captures distant or quiet sound to record the semi-structured interviews. This Dictaphone ensured the capture of all utterances and sounds of the participants. The author downloaded recordings into his encrypted laptop through directly plugging the Dictaphone into the USB port, to ensure no data loss ensued during voice-data transfer. He also kept the recordings in a separate external hard-drive and in Aston University's encrypted Cloud system, as a back up to ensure data security and confidentiality.

The author hired an external agency, approved by Aston's RDP office, to transcribe the recorded interviews. The author has a confidentiality agreement with the transcription agency. All interview transcriptions are held in a full-verbatim and intelligent mode, having timestamps when speakers change. The author uploaded all audio recordings in NVivo. Upon receiving each transcript from the agency, the author attached the MS Word .doc transcript file to the audio recording in NVivo. After that, the author played the sound recording and checked whether the transcriber captured all utterances as per the audio recording, and if his/ her timestamps were correct. The author repeated this process several times, even while coding the data or whenever he had any doubt. Thus, going back and forth and constantly checking ensured that all transcripts are a true reflection of all discussions/ conversations between the author and the interviewee. However, the entire process was hugely time-consuming.

- ***Coding and analysis***

After importing audio recordings and interview transcripts in NVivo, the author followed a thematic analysis for coding (Braun and Clarke, 2006; Pascoal et al., 2014). While coding the author was consciously thinking about (a) what he was reading, (b) did the interviewee's utterance refer to any likely causal mechanism, (c) was the utterance relating to policy, politics, economics, process, or something else and (d) and how all of these interact. The author also kept an eye on how the interviewee interacted, that is, was he/ she talking about one thing but wanting to achieve something else. Did the interviewee mention one thing more often?

The ground rules for coding were taken from the critical realist tools described in the first part of this chapter, that is identification of (a) stratified reality, (b) causal mechanisms or generative mechanisms, (c) emergences, and (d) absences. A causal mechanism relates to the direct effect of action; for example, gravitational pull causes an apple to fall to the ground. Whereas a generative mechanism is a systematic capacity to generate and regenerate the existing relationships, i.e., poverty causes failure at school, and there are mechanisms in a society which produce and restore poverty. In a similar vein, the notion of profit that a firm follows potentially creates and regenerates the demand for consumption of natural raw material resources; whereas the causal mechanism is about a firm taking a resource position to compete with its peers in strategic factor markets and product markets.

The author started by reading each transcript actively and then re-reading each of them several times. The author coded the interview transcripts both manually and in NVivo. It was an iterative process for building initial nodes in NVivo, using simple thematic analysis steps. That is, paying attention to different meanings of the circular economy, thereby creating nodes with data extracts that contained specific, semantic, and latent aspects, to give a detailed account of the understandings of the circular economy. The resource-based view and dynamic capabilities theories informed the coding process. The researcher coded exciting and relevant features of the data, systematically across the data set. This approach involved going back and forth several times searching for patterns, and themes, and reviewing them repeatedly before grouping relevant extracts into different nodes. A group of similar nodes led to developing ideas, which the author discussed again, rationalising them by allocating them a name. These themes were later mapped to the seven steps to answer the research questions.

- ***Analysis of data***

The author conducted data analysis using a systematic combining approach shown in figure 4-2, below. This approach is an extended version of the triangulation method of analysis. All types of data collected, such as semi-structured interview data, observational data, secondary data such as a company's sustainability reports, guidelines for suppliers for purchasing; and the empirical traces of the circular economy distilled from the literature review of the circular economy, were brought together for analysis. Data analysis also included testing the applicability of the resource-based theory and dynamic capabilities view. Systematic combining allows for the use of both inductive and deductive logic (Dubios and Gadde, 2002).

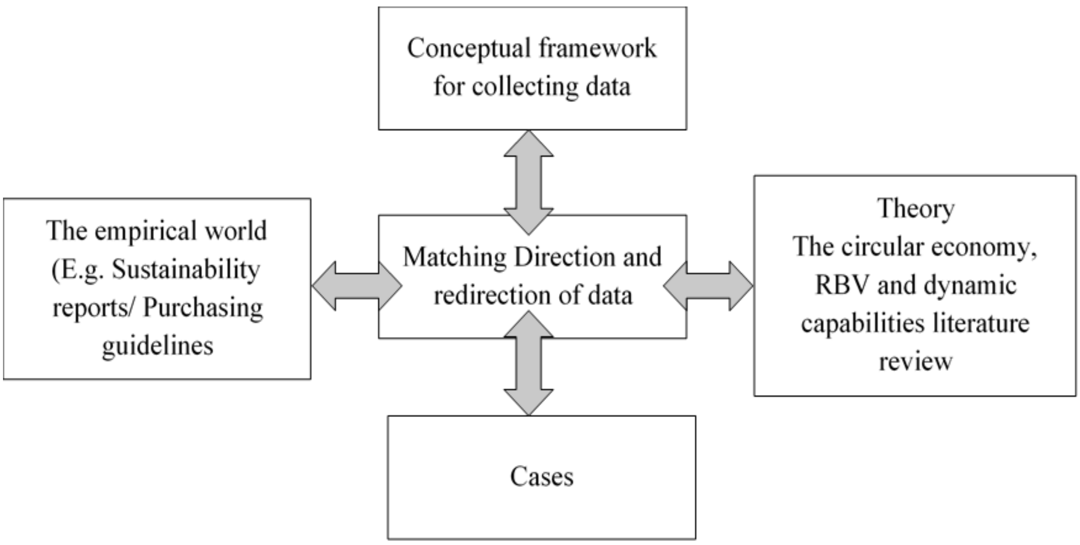

Figure 4-5: Systematic combining of data. Source Adapted from Dubios and Gadde (2002 p. 555)

Systematic combining is a non-linear path-dependent process of combining efforts, with the ultimate objective of matching theory to reality. It is consistent with the critical realist's notion of stratified reality. Therefore, data analysis followed the critical realist belief that causal powers reside in the real domain, and their activation gives rise to events in the actual field, which when identified become experiences in the empirical domain (Ackroyd and Fleetwood, 2000 p 28). Thus, it means that the empirical data collected[33] resulted from activating the structures and mechanisms present in actual and real domains. Therefore, understanding the interrelatedness of the structures and mechanisms that cause such empirical experiences and events to happen would help in developing a compelling and plausible explanation that identifies the reality of the circular economy. Figure 4-3 illustrates the process that the author followed for matching, directing, and redirecting the multiple sources of data between the empirical world (company reports data), theory (RBV and DC literature review), the circular economy (paradigm), and cases (experiences - interview data).

Accordingly, the author, after assimilating the raw data into different nodes, revisited the raw data and mapped it to the seven steps arising out of figure 3-2 in chapter 3. Therefore, the first level of findings is about:

a) The industry trends that interviewees talked about during their interview[34],
b) The manager's academic background and past and recent work experiences,
c) The understanding of the circular economy,
d) The practice of the circular economy by the firm,
e) The way the firms handles its waste,
f) The notion of profit that a firm follows.

From these first-level findings, the author compared the responses of participants from the automotive and IT firms for similarities, differences, and contradictions, at intra-firm and inter-firm levels. These are two separate detailed tasks in their own right:

1. Looking for similarities, differences, and contradictions at the intra-firm level
2. Looking for similarities, differences, and contradictions at the inter-firm level

[33] Lived experiences of the interviewees, and events such as the circular economy-centric exhibitions, seminars, keynote talks, and breakfast meetings to discuss the circular economy, and related secondary data.
[34] The author considers the trends mentioned by interviewees as real, as they are first-hand information about their lived experiences.

These comparisons were necessary because the participating firms were from across the automotive and IT value chain. Even participating government agencies were different, as they did not fall under a single ministry. This exercise was similar to carrying out several experiments on a particular topic and is consistent with both non-critical realist research (Yin, 2018) and critical realist study (Ackroyd and Karlsson, 2014).

However, from a critical realist's perspective, these comparisons helped to identify the causality that resulted from the interactions between structures and underlying motivations/ mechanisms that were in-play. Using retroductive logic allowed for developing a convincing and credible explanation of understanding of the circular economy. It, in turn, helped to identify the characteristics of the circular economy, i.e., those properties that made the existence of the circular economy recognisable. In other words, it helped the author to recognize the reality of the circular economy. In Fleetwood's (2005 pp. 199-201) terms being-ness of 'the ideally real circular economy' is established. All these steps helped to answer the first and second research questions.

After that, the critical realist concepts of emergence and absences helped in identifying the potential abilities/ powers (e.g., decoupling economic growth from resources consumption), of 'the ideally real circular economy'. The characteristics of the ideally real circular economy and its new powers led to testing the applicability of the VRIN framework in this emerging context. It also led the author to verify if the circular economy is a dynamic capability in its own right, as hypothesised in the working definition of the circular economy. The results from these tasks provided the theoretical basis of how economic growth is possible without resource consumption. These steps also helped in identifying the contentious issues that need to be addressed, should the ideally real circular economy concept become mainstream.

The author extrapolated these results to inform policymaking, thereby answering research questions four and five.

4.4 Ethical Considerations

Following the empirical traces of the circular economy in the sustainable development narrative in chapter 2, we come to understand that inherently the circular economy buttresses the ideas of environmental protection, societal benefits, and generational equity, i.e., of an ethical society. However, it is another matter that, by using critical realism, we come to know the reality of the circular economy is entirely different from the inherent expectations of it. This outcome, in no specific terms, means that ethical consideration should be relaxed while conducting its study. Instead, it makes upholding the ethics more pronounced and critical while conducting circular economy research. Any ethical compromise, howsoever minuscule or insignificant it is, defeats the very purpose of conducting this study, because it would mean using unethical means to explain an ethical concept.

The researcher's morals, values, and belief system, also impacts on the ethical issues of their research, contends Lincoln and Guba (1985) and Creswell (2013). In their terms, this is the axiological approach to research. They say that this shows up in the researcher's relationship with interviewees and in his/ her framing of the research topic, the research questions, including the process of data collection, the processing and finally in the dissemination of the findings. Cooper and Schlinder (2008) echo Lincoln and Guba (1985) and Creswell (2013), stressing that all research activities need conducting in a *morally* responsible manner.

In line with this, the author has taken the utmost care at each step of the research process to adhere to the highest possible ethical standards. The author has mentioned only superficial information about the participating organizations in this thesis, allocating generic names to the interviewees to ensure their confidentiality. Only after obtaining consent from the interviewees did the author proceed with the interviews. The author made it explicitly clear to the interviewees that their participation was voluntary, and that they can end the conversation at any time, should they wish to do so. He also informed them that he was following confidentiality guidelines as set out in the Data Protection Act, 1998, and Aston University's ethical policy guidelines.

Furthermore, the author informed the interviewees that he would be recording the conversation, and audio-recordings would be retained in an archive for a minimum of four to five years, for checking purposes in case of any query arising concerning the research. He also informed them that his two supervisors would have access to the recordings. The author told the interviewees that he would ask for prior permission if he wished to publish any quote from their response in any of his publications. To maintain transparency, the author sent a transcript of the recorded conversations to the interviewees for their checking and approval, and was open to any amendments they wished to make - about eleven per cent of the interviewees responded while the rest did not. The author took their silence as approval.

This research has the approval of Aston University's Ethics Committee and follows the ESRC code of conduct. The study maintains the highest ethical standards at two levels: (a) protecting the interests of interviewees, and (b) ensuring accuracy, internal and external validity, and avoiding selective reporting of the findings.

On a personal front, the author following Vincent and Wapshott (2014) has practised reflection and reflexivity with utmost sincerity, consistently throughout the research process. The author is of the view that reflection and reflexive exercises enabled him to be more self-aware, allowing him to detach himself from his research work. These exercises, in turn, made it possible for him to present the unbiased reality of the circular economy and offer new perspectives on the existing theories/ frameworks. Practising reflection and reflexivity for several years during this study has made it a second habit for the author, and he thinks this will help him to emerge as an ethical and independent academic researcher.

4.5 Conclusion

Critical realism enhances the explanatory powers, providing clarity between entities and mechanisms, or between real, actual, and empirical levels of reality. Also, it helps to distinguish between possessed, exercised, or actualized powers. Moreover, its commitment to provide *the alethic truth* and full explanation offer an approach that accepts that beliefs can be false, and that identification of those mechanisms that create false beliefs could be liberating. In strategic management terms, it equips managers to take a critical approach for planning and policymaking. The next step is to apply these concepts to the empirical investigation that will be the subject of chapter 5.

Chapter 5 Findings

5.1 Introduction

This chapter reports the awareness, lived experiences, and the understandings of the circular economy in the automotive and IT firms, and government agencies, following on from the seven steps that resulted from the conceptual framework presented in figure 3-2 of Chapter 3.

The detailed account of all thirty-four interviews are mapped to the seven steps in NVivo, and the responses data from each interview are grouped under the following heads, such as (1) the participants view about the industry trends, (2) the information about the business activity of the firm, (3) the roles, responsibilities, academic qualification and background experience of the manager, (4) the lived experiences of each participant about the circular economy, which in turn, informs about the firm's understanding of the circular economy (5) how the firm practises the circular economy, (6) the firm's handling of waste, and (7) the firm's notion of profit. Figure 5-1 offers a visual of the coding map of the seven steps. Also, figures 5-2 and 5-3 provides visual maps of all the nodes coded under the fourth step – 'the participant's understanding of the circular economy, and the fifth step – 'the operationalisation of the circular economy'.

All through this chapter, a summary of each interview has been provided structured around the seven steps often presenting the representative participant's quotes that contribute to the interpretation process in Chapter 6, for answering the research questions. Tables 5-1, 5-2, and 5-3 presented just before summarising all interviews in each Case, provides an overall summary of the seven steps mapped to each interview data.

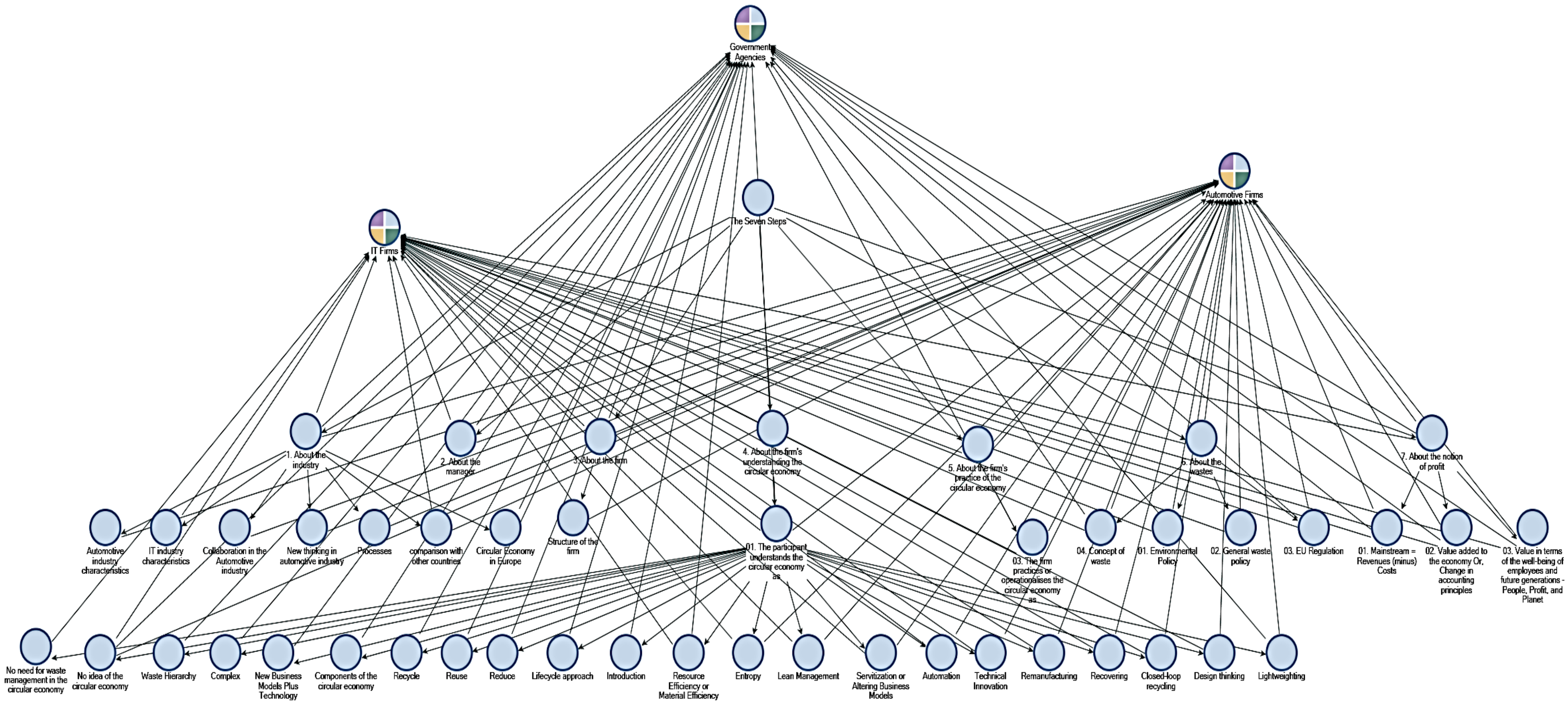

Figure 5-1: Coding map for The Seven Steps

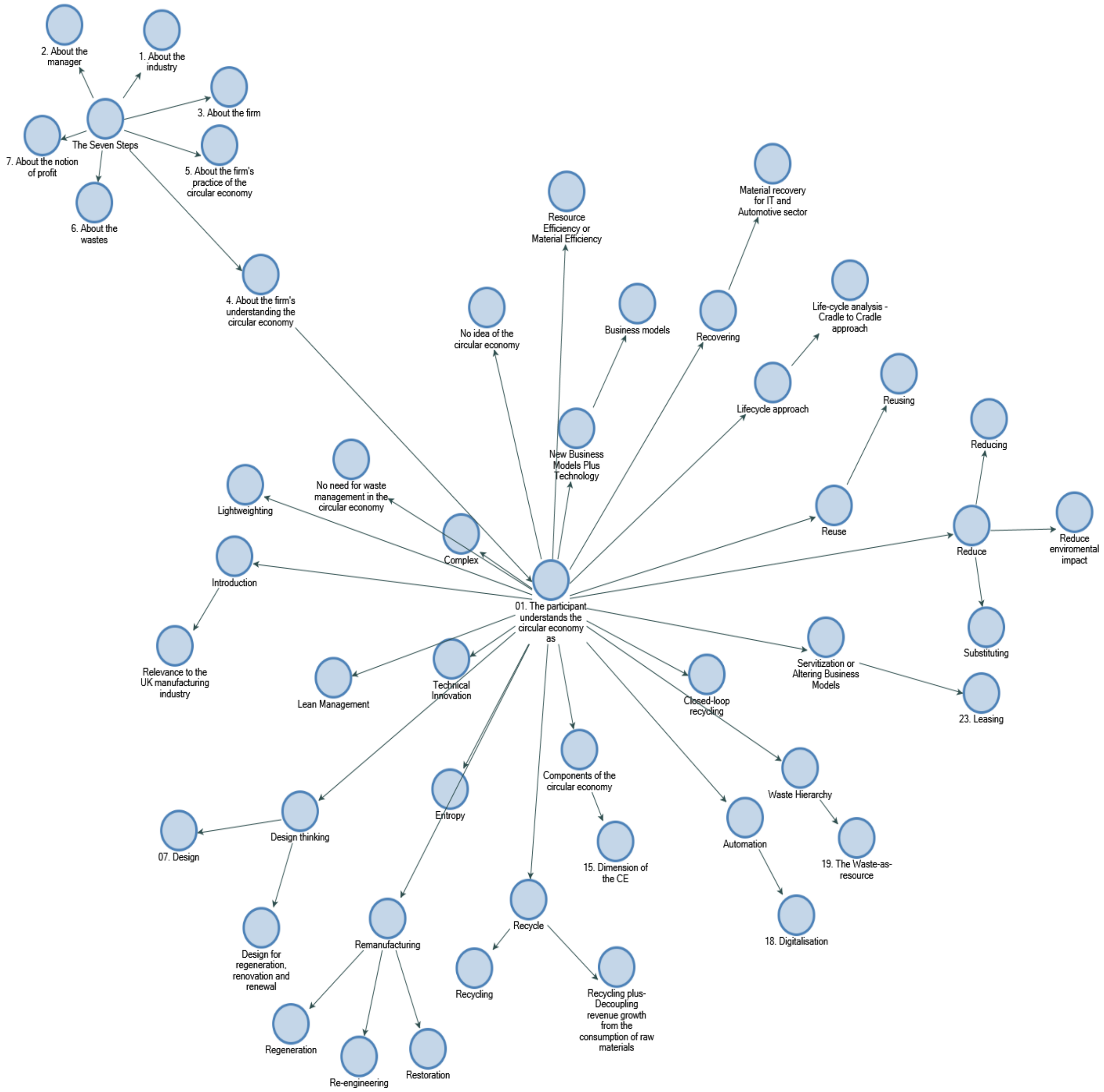

Figure 5-2: The 4th Step - The firm's understanding of the circular economy

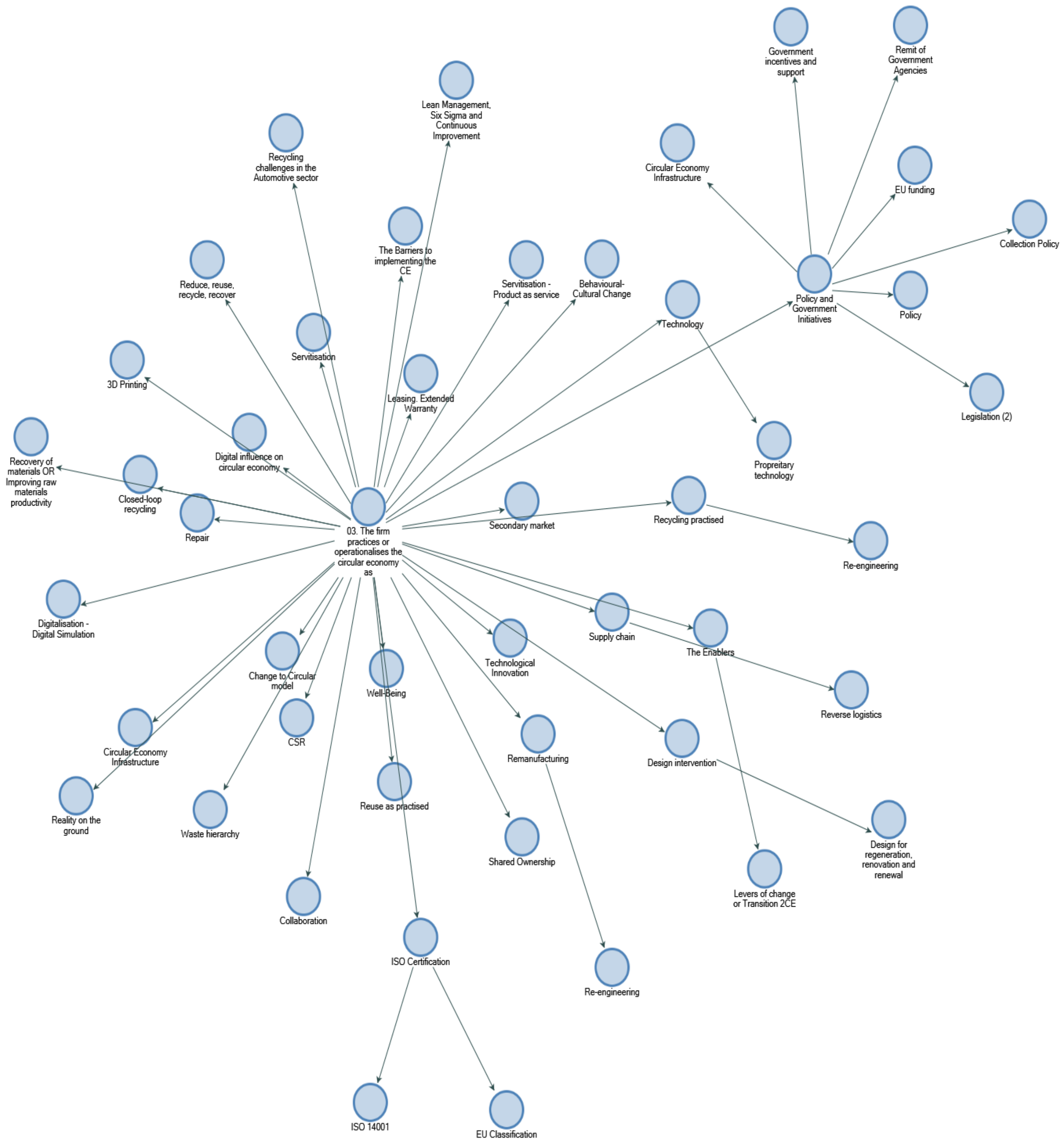

Figure 5-3: The 5th Step -The firm's practice of the circular economy

5.2 Inner- Nest Case 1: The group of UK Automotive firms

Eleven participants from the UK automotive firms participated in this research study. The breakdown of eleven participants coming from five different business streams are as follows: Three participants each from (a) original equipment manufacturers, (b) recycling businesses, (c) remanufacturing businesses, and one each from (d) raw materials consulting, and (e) the flagship trade association.

Further, the original equipment manufacturers cluster is composed of one premium car manufacturer, one fuel-efficient car manufacturer, and one hydrogen fuel car manufacturers. Whereas the recycling businesses cluster includes one aluminium metal recycler, one non-ferrous metal recycler, and a polymer recycler. Similarly, the remanufacturing business group consists of an electronic component manufacturer, one mechanical component manufacturer, and a waste-heat batteries manufacturer. Additionally, other businesses included one raw materials consultant, and one member of the flagship trade association thus, making a total of eleven participants. This UK automotive sample is well balanced for providing comparisons for similarities, differences, and contradictions.

5.2.1 Trends in the UK automotive industry – A collective view of the participants'

The UK automotive industry is very conservative and process-driven in its approach, which stems from it being involved in transporting human lives. The purchasing process is hierarchical, including a whole range of suppliers, including recyclers, remanufacturers, and consultants across different industry sectors, constituting its supply chain. There are strict qualifying procedures (including the often problematic, subjective component) to pass before any company can become an authorized supplier to a large OEM. Most OEMs usually grade their suppliers as tier 1, tier 2, or tier 3 suppliers

The large OEMs enjoy positional powers because of their scale of bulk purchase and massive annual purchasing budgets. As a result, the responsibility for technology development often gets passed to tier 1 and tier 2 suppliers, with the expectation that these suppliers develop products in-house that need supplies. Such requirements act as an entry barrier for local SMEs, local technology developers, recyclers, and remanufacturers, as they vie to be a part of the large OEMs supply chain.

The adoption of new technology is incredibly fast amongst large OEMs because the automotive industry is a capital intensive and low margin business. As a result, both approved as well as non-approved suppliers adapt to new technological changes very quickly. The large OEMs often use their positional powers to negotiate very hard, making it mandatory for their approved suppliers to align their production processes and procedures to that of their own. Thus, for all practical purposes, the approved suppliers become an extended arm of a large OEM, without the OEM making any investments. This arrangement works for both. The large OEMs benefit because it becomes easier for them to introduce any changes to the supplier's production processes/ procedures, as suppliers' have fewer people involved in the decision-making process. The suppliers also benefit because of the assurance of large purchase orders that ensure the continuity of their business. As a result, the competition between suppliers is very tough, as each one tries to be a part of the large OEM's supply chain, which, in turn, lowers the supplier's margins.

The cumulative effect of this is that the UK automotive sector becomes a high technology, highly competitive business, having low margins, resulting in it being cost oriented, expressed in a representative quote, below:

'…again, in the automotive industry I think [it] is, and I am, you know, somewhat ashamed to say, it is extremely cost-driven. It is a very low-margin industry, so a focus, a major focus is on cost. So, if anything [it] is [been] seen to be an opportunity to reduce cost in some way, and reuse would be an example of that, - it has got some attention, and I think that is as true today as it was yesterday. The difference I think we are heading into is that in the past, that focus has been more internal…' P4

All car manufacturers are now focusing on electric and autonomous vehicles. Most recent innovations include hydrogen-fuel cell cars. It is possible to store waste heat energy emanating from the internal-combustion engine in electrical batteries for later use, either to fast warm a passenger bus cabin or to quickly warm up a diesel engine during the winter season. Similarly, there are several research and development projects for improving (a) battery technology, (b) usability of raw materials resources, (c) fuel efficiency, and for reducing (d) the use of prime virgin materials, and (e) the overall vehicle weight, especially in components such as power train, chassis, and tailgate emission.

The UK automotive sector is also witnessing non-conventional players such as Dyson® and Google® who are developing connected and autonomous electric cars. Also, Uber®, a taxi service company, is developing a city-based aerial transport system to move people efficiently from point to point, reducing road congestion and environmental pollution. One of the participants summed up the impact of these developments on the UK automotive market, described in the representative quote below:

'…A circular car means one can recycle, refurbish, all the components used in the car […] This means that the manufacturer will still be the owner of the car. The private ownership will disappear; the manufacturer will use the car-as-a-service. So, I can see that if you use a specific shape of a car and you have a modular board on that. For instance, is connected to a 4G network in 10 years; it might need a 7G network connection […] So, this requires a manufacturer who can take the car back, update it, make it suitable for 7G network. It can come back on the road again, and maybe after

doing some refurbing on the interior or whatsoever, it is as good as a new car. Therefore, a circular car becomes more and more important. [...]The biggest impact on the automotive market is that the car market will shrink. In the future, there will be fewer cars on the road, and the ownership will change from private ownership to the manufacturer…' P5

The collective view of the participants, in Teece (2012, February), and Eisenhardt and Martin's (2000) terms, the current UK automotive sector resembles a moderately dynamic market. It is moving towards becoming a highly turbulent market as the cars become more modular and autonomous equivalent to 'computers on wheels.' The new emergent market structure has all the features of the next generation competition, as explained by Teece (2012, February p.99). That is, having fluid market structures, modularization, depending upon firm-level clusters of know-how, marked by dispersed technologies supporting eco-system level of analysis, and being innovation-driven by combination and recombination of resources and techniques[35].

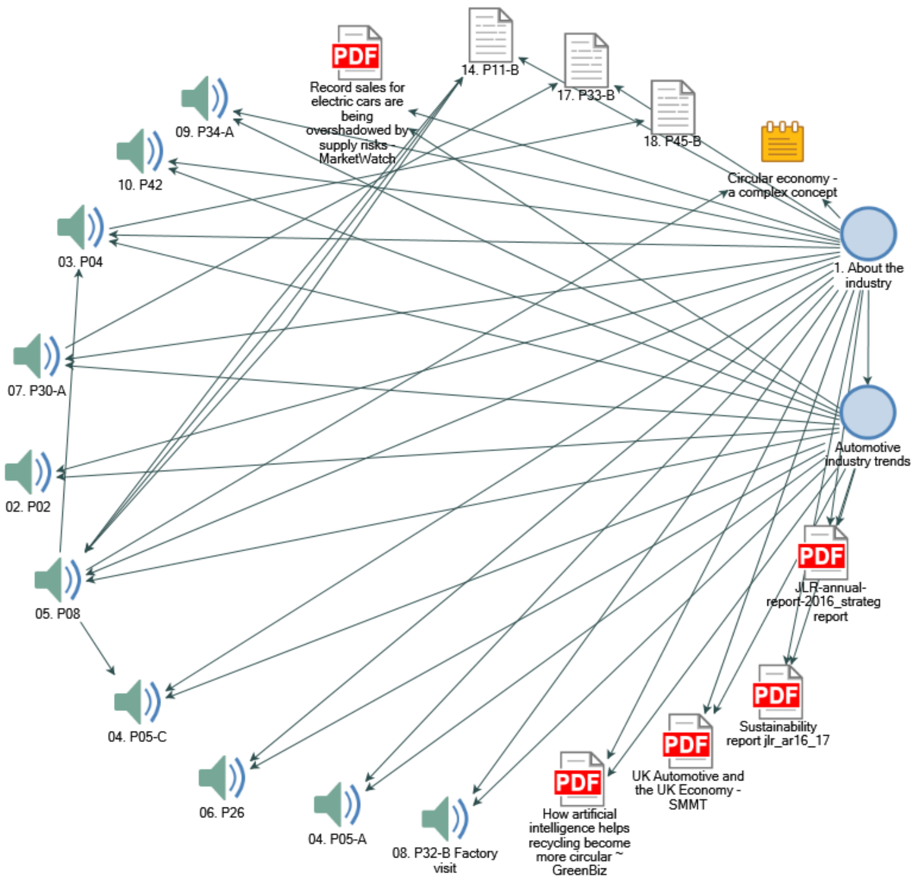

Figure 5-4: Coding map showing participants' responses for trends in the automotive industry

[35] Drawn from Table 3-9 in Chapter .3

5.2.2 Details of Inner – Nest Case 1: The investigated UK automotive firms

1. **Summary of firm 1**

The first firm is from the premium car segment. The company's corporate belief is 'Sustainable economic growth can only be achieved if the environment and the society in which the company operates is protected. Its goal is to decouple business growth from environmental impact' (Automotive-PLC, 2016/17 p.16). Historically, the initiative to reduce environmental impact stems from Dame Professor Julia King's review of low carbon cars (King, 2007 October).

The interviewee manager is a mechanical engineer having a background in metallurgical engineering. He heads the 'Sustainable Aluminium Strategies' department. His role involves looking for an opportunity to introduce new metals alloys in the vehicles' body structures so that the overall weight of the car is reduced. The company has found that aluminium metal is fit for reducing the weight of their vehicles, thereby reducing GHG. Therefore, they are transitioning to an aluminium architecture for all their vehicles. As a result, it has led the company to collaborate with the largest aluminium metal recycler to ensure a steady supply of aluminium ingots made from recycled aluminium.

The manager, as well as the company, understands the circular economy to be a sustainability drive. They know that being sustainable is to become a closed loop. For them, the circular economy and being closed loop are the same thing, evidenced by this quote below.

'…the sustainability aspects of aluminium, and now as before circular economy was a term I have not even heard. We just talked about closed-loop being as sustainable as we could as a business...(P1)

However, the manager confirms that the understanding of the circular economy is not clear, as it should be for his company. Most people within the company do not understand the circular economy term, but when it gets linked to the environmental initiative and sustainability, they do understand.

The company has adopted the circular economy term due to its popularity, but it does not alter their ways of doing things, and they continue to do things as before:

'...So as we started the work and the fact that we were calling this a sustainability project or environmental initiative, and now talking more around the circular economy terms, it did not alter what we are doing on the project'. (P1)

The interviewee considers sustainability to be a broad term, while the circular economy is a subset of it, but is not too sure about it. The company practices the circular economy as recycling, evidenced by this quote.

'...So, it's to me, it is about the valuable assets that are materials to make the most of them, bring them round and just to bring them round again and again, that is what circular economy is ...'P1

The ReAL car projects are about 'Recycled Aluminium.' ReAL car projects aim to increase the recycled aluminium content in the car as it reduces the production costs as well as making the car lightweight. Reducing production costs increases profit margins, as well are improving environmental performance. To lessen the contamination of scrap aluminium, and to get a high quality of recycled aluminium, the company has collaborated with the largest aluminium recycler, Novelis, thus creating a closed-loop for themselves.

'... typically, we return what we have as much as we can to Novelis, and because they all recycle back, they remelt back into ingots then go to background into sheets again.' P1

Concisely, the company understands and practices the circular economy as recycling. The participant acknowledges that the circular economy is becoming complicated, multi-dimensional, and cross-sectoral, and often, people conflate it with sustainability (meaning sustainable development).

The company has a waste management policy but does not have a standard operating procedure concerning waste. However, the participant spoke about a contradiction regarding waste. Having an arrangement with Novelis means they need to generate waste to enable Novelis to return aluminium ingots made from scrap aluminium, for production. However, it is not in their interest to cause residues because they have targets to reduce waste generation.

The company follows the mainstream notion of profit, i.e., maximizing returns on investments to please the shareholders.

2. Summary of the firm 2

The second firm is a multinational corporation, which is the largest producer of fuel-efficient cars in the UK. According to the company's 2018 sustainability report, since 2010 the company has sold more 320,000 electric vehicles with zero-emissions (SR, 2018 p. 3). The company is at the forefront of developing technology for vehicle electrification and intelligent mobility. The company's goal is to contribute towards building a sustainable society by promoting (a) society's de-carbonization through electrification and intelligence of vehicles, and innovative future Monozukuri[36], b) reduce dependency on raw material resources[37] (circular economy), (c) cleaner exhaust emissions, and (d) reduce water consumption and manage water quality (SR, 2018 p. 46).

The interviewee manager is a technical specialist having a background in metallurgy and advises the design engineers about material selection and application. His responsibilities include the use of recycled materials, bio-based material, and developing an environmental strategy that complies with the European Union's legislation such as REACH[38].

The manager and his team understand the circular economy as recycling as he stated this:

'…if you walked outside here, you could speak with any of our design engineers, and they are very aware of circular economy and the reuse of material in future applications…' P34

The manager understands the circular economy that sustainably applies materials, recycles, and recovers whatever possible, eliminates landfill wherever possible, conserves natural raw material resources, and makes sustainable energy applications. For him, the components of the circular economy are recycling, recovery, and reuse, and the life cycle analysis decides the selection of raw material resources. A circular economy requires everyone to work together. The life cycle analysis is not similar to the Cradle to Cradle™ concept of Prof Braungart and McDonough because they omit the biological nutrient component of the Cradle-to-Cradle™.

'…That is why [we] have to consider everything as a lifecycle analysis to make sure it is a complete cradle to grave consideration of the material, the components, the application, and how it is recycled. It involves considering which material we will select for an application from the beginning of the product life, right to the very end, and then how we can reuse it…' P34

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[36] Monozukuri is used to describe integrating technology, processes, production, and procurement and includes intangible qualities such as craftsmanship and a commitment to continuous improvement'

[37] As mentioned in the Internal copy of Corporate Environmental Principle, page 3.

[38] REACH stands for Registration, Evaluation, Authorisation, and Restriction of chemicals –It is the EU legislation to protect the human lives and environment from the risk posed by chemicals while enhancing the competitiveness of the EU chemical industry.

The manager was not able to clearly distinguish the difference between sustainability and the circular economy:

'…There are clear differences between the two, but they are very much interrelated. Sustainability, […] applies to many biomaterials in a product, using natural fibres within components […]; however, this may not be suitable for a circular economy because once it has had its initial life, it could not be applied again in a similar application. So, that does not fulfil the circular economy, but it would achieve a good initial environmental performance…' P34

The circular economy is practised in the form of recycling and recovering materials, either by altering the chemical composition of the raw materials, or by combining both virgin and used resources. The company uses a circular economy for its brand strategy.

'…Because of this limited resource availability background, we try and maximize recycling and re-use of materials. So, quite a large percentage of our material application is basically from post-consumer or post-industrial recycled materials. So, here in the UK, we work with a large number of recyclers who develop materials to meet the specific [XXX] requirements…' P34

The understanding of the circular economy is not uniform across the company, which contradicts the initial claim of the interviewee that the circular economy is well-known across the company.

'…Aye, it is something that is widely practised and preached within our organization…' P34

The company manages waste under its Green Programme. The 'Green Programme' has continuously evolved since 2005. Its objective has changed from 'improving the environment of the cities and local inhabitants' to 'overcoming the Earth's limits through the creation of social values'.

The explanation given in response to the notion of profit explains that traditionally they are following the mainstream idea of profit, i.e., lowering the cost of production to improve profit margins. Hence, they follow recycling for reducing production costs, branding themselves as a circular economy compliant company.

3. Summary of the firm 3

The third firm in the OEM segment is a new start-up, which is all set to disrupt the UK passenger car market. The company plans to sell services of the car through subscriptions rather than selling the car as a product. It has received a £2 million grant from Innovate UK® to develop further the idea of hydrogen fuel cell car. A hydrogen fuel cell has an advantage over internal combustion engines and electric vehicles, as it completely replaces fossil fuels and battery technology. Therefore, hydrogen fuel cell cars are the best for minimizing CO_2 emissions. The company has finished developing and testing the prototype, but is yet to commence commercial production.

The interviewee is the Founding Director of the company, having an academic background in Business Administration. The hydrogen fuel cell car is a spin-off from his MBA project set up in 2000. He believes that being less sustainable does not mean being sustainable. Sir Paul Hawken influences his belief system, as he says;

'..So, none of these ideas is mine. As Sir Paul Hawken informed about the fuel cells, who wrote about the ecology of commerce, and he often says […] we have to develop a more sophisticated form of capitalism that recognizes natural and social capital, as well as financial capital. It means moving from a world where we manage supply to meet the demands, to a world where we manage demand to meet supplies.' P42

The interviewee does not understand the circular economy and equates it to the servitization model. For him, servitization and circular economy are two sides of the same coin. He feels that the circular economy is a buzzword that is poorly understood.

The participant has some radical views on conserving the natural raw material resources, and consumption. He says that currently the automotive industry rewards increasing resources use because of low-profit margins. Hinting at the rebound effect that results from achieving resource efficiency, the interviewee thinks the circular economy should focus on managing supplies rather than creating and managing demands. In so doing, all operating costs need internalizing; as well as rethinking of accounting so that products and resources stay on the same balance sheet even when they not physically on the owner's premises.

Currently, there is no evidence of the company practising a circular economy. However, the interviewee offers an alternative way. That is, by changing from business models focusing on managing supplies to meet demand, which would help in decoupling economic growth from resource consumption, thereby safeguarding natural raw material resources reserves and environmental protection.

Similarly, there is no evidence of a waste management policy. However, the interviewee is in favour of taking on the ‘extended producers’ responsibility’, evidenced below:

‘We have a sustainability engineer whose role includes looking at the way we run all the systems in our business. So we do what we can in minimizing things, but we just again prioritize getting ourselves to market, and we have got enormous challenges on the way. Furthermore, we think looking at our big picture; we do create some plastic waste. We do recycle what we can, so on and so forth. However, people go and buy sandwiches from Tesco in a plastic container, and we would love to get beyond that.’P42

The notion of creating social value underpins the idea of profit. In this regard, the company has a different governance model, where the investors do not control the business, which is in their interests as well. It is a partnership model involving all critical stakeholders who are responsible for the success of the company without prioritizing anyone's interest. Some investors do not prefer to invest for this reason, whereas for some others it is the critical reason to invest.

The participant believes that such a governance model would allow them to:

a. get a level of goodwill from all critical stakeholders,
b. be able to have a much healthier balance between short- and long-term decision making,
c. not take risks on behalf of investors to maximize the financial return to investors, because it would require the agreement and support of all the other stakeholder groups, and
d. make the business more resilient. Moreover, for investors, resilience is more important than profit because one can have a profitable business but not be resistant to external shocks, whereas a resilient business is beneficial most of the time.

4. Summary of the firm 4

The fourth firm is a traditional yet leading producer of flat-rolled aluminium products and the world's largest aluminum recycler. Its footprint spreads across ten countries on four continents, but they do not have any single source of primary aluminum. The company has successfully created the first and largest closed-loop recycling systems globally. It is also the world's largest supplier of beverage can sheet metal. The company is a member of the CE100 club.

The interviewee is the senior manager for sustainability and recycling development. He has a background in geological and Earth sciences, and integrated environmental management.

The manager says that the company has been doing closed-loop recycling for the last 20-30 years, but not calling it the circular economy:

> *'…Well, the circular […], in terms of phraseology, it is a great invention. A great invention, and what it means is, we have been doing it as a reprocessing business. A business that's founded quite a lot of this activity on recycling and reprocessing…' P2*

The company understands the circular economy to be recycling. They consider themselves to be practising the circular economy due to the inherent ability of aluminium to be recycled infinitely. Since they are recycling, the company uses a circular economy for their branding purposes, evidenced by the response below:

> *'…The circular part of our business is around recycling…if there is a DNA of something that is inherently circular. Then one would start jumping on the bandwagon a little bit around circularity and branding the business as a circular business…' P2*

However, branding itself as a circular economy business has not changed anything operationally. The interviewee states that the company treats the circular economy as a buzzword, and it has not gone down well within the company as the term 'circular' often confuses most of the managers. It is confusing because managers are not able to find start and end points. Everyone is using the circular economy terms to describe whatever they are doing, e.g. even reusing shoes is being referred to as 'doing a circular economy'. The interviewee feels that 'economy' in the term has an excellent potential to create long term good economic relationships around the productive use of materials, but very few businesses are doing it.

The interviewee flags the dynamics playing within the CE100 club, disclosing his displeasure on how the EMF treats the recyclers.

'... let us be perfectly candid though, when we talk about the license, Ellen MacArthur and their foundation is an interesting one. We would say we feel a lot like the poor cousins really when we go along there, and we are the world's largest recycling company for aluminum, but they treat us as just another recycler. The conversations going on around the table, Ellen MacArthur, are much more around disrupted business models that are around, trying to change consumption patterns and etcetera.' P2

This response is pointing towards the EMF's inclination to project the circular economy that centres around innovation and its interest in focusing on economic prosperity, distancing the circular economy narrative from environmental and societal benefits, including generational equity, as highlighted by Kirchherr et al. (2017 p. 228). Theoretically, this response highlights that the EMF focuses on Schumpeterian notions on growth, targeting Schumpeterian rents achieved through creative disruption while promoting the circular economy narrative (Schumpeter, 1934). Additionally, this response also highlights the membership fees that the EMF charges as 'License fees.'

The interviewee reveals that because theirs is a recycling business, they brand themselves as a circular economy business. However, in practice, no one is concerned about using virgin or recycled aluminium while producing a beverage can. They use whatever costs less, and virgin aluminium costs less, although it requires enormous amounts of energy to extract pure aluminium from bauxite. He calls it is a cartel market.

'…they are just producing cans. It is a commodity. They are just producing cans. Moreover, they do not care whether they make it from a primary, coal fire, high carbon intensity aluminium as against low carbon, recycled content [-you would have to respect this confidentiality. It is a cartel market].' P2

Recyclers collecting scrap from different sites creates the issue of contamination, which in turn impacts the quality of aluminium ingots mass-produced from such recycled materials. Also, picking from different places requires investment in vehicles, as well as the carrying capacity to deal with the number of press shops that a company can install.

Operationalizing the circular economy as recycling, the manager understands closed-looping as part of the recycling process - the company tailors closed-looping with its known customers, to protect the interests of all parties involved.

'Our UK relationship with Jaguar Land Rovers is a pretty critical one for us. We have done a pretty good job in working with people like Jaguar, where we designed a new alloy or a recycled content-based alloy to accommodate that closed-loop process.' P2

This response by the interviewee points towards the unobservable mechanisms playing in the background. An Indian multinational has acquired the case company's parent firm, 'ALCAN.' Likewise, the TATA group, another Indian multinational, bought Jaguar. So, the 'crucial relationship' that the interviewee is talking about is an agreement between the senior management of both Indian firms, agreeing to increase the recycled content as it serves the interests of both. Also, culturally, both share the same background. However, increasing recycling content does not address environmental challenges.

The company manages its waste under the global environment program. The company follows ISO14001 and has targets for reducing the consumption of water, energy, and greenhouse emissions. Also, they have zero waste and zero-to-landfill goals for complying with statutory legislation. Reducing energy consumption is critical for them because it helps save direct costs. However, the participant says that achieving zero waste is unachievable, highlighting waste challenges that the company faces.

'…[The] waste challenges are different, we did not understand it, let us be honest, you know, zero is pretty much unachievable.' P2

Theoretically speaking, the interviewee's response resembles the Penrosian idea of zero waste expressed on page 69 in the footnote number one[39].

One of the waste challenges is the metric itself. Increasing aluminium recycling content means generating more scrap so that it can be recycled. Creating more scrap for increasing recycling tends to lower the quality of waste, which ultimately impacts on the quality of the finished product manufactured using the recycled content. Another issue is weight-based the metrics for recycling rewards, the generation of more wastes defeating the zero-waste initiatives.

In response to asking how waste management can be improved, the participant said that currently a lot of aluminium powder is lost, which results from shredding aluminium before putting it in the furnace. A proactive approach would be to create a product of powered aluminium that is sustainable, instead of losing it to the cement industry or allowing it to go to landfills as it is difficult to ascertain such losses.

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[39] The concept of zero waste is utopian, as Penrose (1959) in p. 69 footnote gives the example of 'an industrial engineer in charge of product development in a firm is quoted as having stated: "Every time we make something, we have something left over, and have to find something to do with that. And when we find something to do with it, we usually find that leaves us with something else. It is an endless process" A.D. H. Kaplan, Big Enterprise in a Competitive System (Washington D.C.: Brookings Institution, 1954), footnote, p.191'.

These responses also point towards the unobservable structures and mechanisms playing in the background that favour waste generation. The interviewee was probably hinting at the vested interests lobbying for legislation that allows weight as a metric for evaluating recycling.

The interviewee's notion of profit is similar to that of the company. That is, maximizing the return on investments made, which is evident from the financial ratio EBITDA[40] used for evaluating its project performance.

> *'…Well, in purely economic terms, when we set the sustainability goals at the company back in 2011 […]. If we have not got a financially viable business, it does not matter how sustainable or how environmentally beneficially it is, if it does not make money, we do not have a business.' P2*

The company is a member of CE100 and projects itself as the messenger of the circular economy, but focuses on maximizing returns, giving less importance to the environmental and societal dimensions of the circular economy.

5. Summary of the firm 5

The fifth firm is a family-owned waste management company, operating from South Wales in the U.K. for over thirty-five years. They collect all types of waste, such as recyclable materials, metals (ferrous and non-ferrous), glass, plastics (hard and soft), domestic and co-mingled waste, paper, cardboard, hazardous waste, etc. They pride themselves on being committed to recycling in the region.

The interviewee is a metals recycling manager. He asked to include the divisional manager in the interview. Academically, both were not qualified, but they did have rich experiences within the recycling business, and both had been working with the company for over fifteen years.

They understand the circular economy as recycling. That is, getting the most out the end of life vehicles, through recycling scrap, often involving processing the waste. Both were unable to differentiate between sustainability and the circular economy.

The divisional manager described circular economy as taking someone's scrap or waste and then processing it, with the help of supply-chain partners, and then putting it in the materials and commodities market for someone else to use it. They do this with any recyclable materials such as cardboard, plastics, and metals.

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[40] EBITDA stands for Earnings before interest, tax, depreciation and amortization.

The participants highlighted the gaps in the government's waste policies and the presence of unobservable structures that impact on the outcomes. For example, all wastes that are received and go out from the site are logged according to the European Waste Catalogue code (EWC) and measured in weights. At times, waste booked under the general waste category and allocated a particular EWC code also includes scrap metals, e.g., a radiator, which has a different EWC code. The entire process depends upon the correct classification of material, which is not easy to monitor because of the complexity involved in the EWC. Such instances allow unethical practices to germinate.

Another example is weight driving the selling price of the material, including the discount offered on a particular substance. That is, if a bale is greater in weight, then the selling price of an element from that lot will be less.

Similarly, the process of issuing permits to waste management companies is not straightforward. There is a gap between legislation developed by the Environment Agency and the way waste management operators function on the ground. That is, the Environment Agency changes law overnight without consulting the waste management operators. As a result, all investments made by the operators in plant and machinery can suddenly become redundant. Such events lead to malpractice and is a detriment not only to the waste management sector but also to firms that rely on waste as resources for their production - as this quotation shows:

'…a classic, just as an example, in 2005/2006 they brought in pre-treatment legislation to say that nothing could go to a landfill site that had not been through a transfer/ processing station, or materials recycling facility. The waste must be through inspection. There was no clarification as to whether that was mechanically, physically, poke it with a stick, kick it with one's shoe, it was just total- total…it was very flimflam. It never actually really materialized. There was a loophole. For example; if on a desk, there is a cardboard tray to take paper, and that waste paper was going into that tray, then it is considered to have been effectively pre-treated (the material). So, therefore, the collector Biffa, Veolia or, whoever, can take that waste straight to a landfill site because it has been in the Environmental Agency's eyes pre-treated because the legislation was so woolly…' P48

The participants spoke about the biased approaches of the local enforcement officers appointed from time to time by the Environmental Agency, including their lack of engagement with recyclers before making legislation. The participants signposted the illegal activities carried out by small-time waste handlers taking advantage of the loopholes in waste legislation.

'…There is a guy down the road here, he has just filled the site with rubbish, and he has gone. I have informed the Environment Agency that is happening; they do not take it on board. You know, I dare say there are other reasons- other reasons, they do. The Environment Agency has been inept in its approach. When somebody can fill a site with one and half million pounds worth of liability. That is physical liability the taxpayers going to pay, and as the operator of that site after nearly three years of being pursued through the court, gets fined twenty-five thousand pounds, who are the mugs?' P48

For them, the notion of profit is essentially maximizing return through reducing the cost of purchase of waste. Such cost-cutting could also involve overlooking compliance and regulations, and the use of illegitimate means for cost-cutting. The waste sector is prone to pilferages and cartels both within and outside the country.

The participants highlight theory-practice contradictions and the exercise of position power. It shows the gaps in the implementation of policies developed at the national level, providing examples of the results of mechanisms playing in the background.

6. Summary of the firm 6

The sixth participant firm is a mid-tier private limited company selling recycled polymers into the recycling market. The company was established in 2002 by two chemical engineers, sensing the opportunity stemming from the 'extended producers' responsibility' legislation for the packaging industry. Currently, the company has five shareholders. The other three shareholders, apart from the two chemical engineers, are from a well-reputed large metal recycling company. The metal recycling company has approximately fifteen per cent market share of the UK's scrap metals market, controlling about twenty per cent market share of the end-of-life car market[41].

The interviewee is one of the chemical engineers responsible for commercial operations and new business development. He understands the circular economy as recycling, considers it as a buzzword, and brands his company as circular economy experts in the hope of generating more business.

'We are selling polymers into the recycled market. We are selling aggregates, and we are selling solid recovered fuel. We employ ninety-five people. We are turning over, over ten million pounds. So, we are a successful model of the circular economy working

[41] The UK scrap metals market is estimated to be generating around 11.5 million tonnes, out of which the metal recycling company captures about 1.4-1.8 million tonnes-– approximately about 15% market share of the total UK scrap metals market. There are about 32 million vehicles in the UK car market now, and the average mass of a vehicle is about 1.3 tonnes, with a life term of about 13.5 years of each vehicle. This means there are a about 2.5 million vehicles getting added into the waste stream every year, and since metal recyclers have two big car shredders their market share is estimated to be approximately 20% of the total scrap car market.

already, so we have decided to kind of rebrand our consultancy business, as the circular economy experts, in the hope that it opens up many opportunities to do consultancy work, we know it is a buzzword.' P32

The interviewee was approached by the EMF to become a member of the CE100 club, but it seems they did not join because of the high club membership fees.

'...she's, oh, well you have to join the Ellen MacArthur Foundation, thirty thousand pounds a year, And I said, well, why should I join your thing for thirty thousand pounds a year? When you would be so interested in what I do, that we are the ones who are doing it. You should be paying us money to come and visit us.' P32

The participant notes that the understanding of the circular economy is mixed. Senior management of FTSE 100 companies, who are members of the CE100 club, understand about circular economy and the opportunity it offers, including people with an academic background in environmental sciences or sustainability. He thinks neither the EMF nor McKinsey & Co are aware of the reality of the circular economy.

'You know, how many people at McKinsey's have ever been to a factory? How many people at Ellen MacArthur's have ever been to a recycling plant? It seems to me that if you are going to talk with a real foundation of credibility in this field, yes, you need the ivory tower, the big picture, the visionary thinkers. Still, it needs anchoring in some reality of what it is like actually to do it.....' P32

He says, usually, middle management personnel do not understand the meaning of the circular economy as they are too busy chasing their targets, e.g. a purchasing manager who is after saving five per cent a year does not even think about the impact the purchasing decision has on the environment. For him, a circular economy is about using the maximum percentage of fully recycled material for manufacturing new products. Therefore, this necessitates not only tracking where their metals came from, but also developing metrics that help to ascertain the percentage of recycled materials that can go for manufacturing products, so that the products perform at their best. Such parameters apply to those that consume more metals, such as automotive, aeronautical, shipbuilding, and packaging sectors, and could be the basis for competition. An excellent performing circular economy would then look like a place where manufacturers are linked to resource recovery industries, so that seventy-five per cent of their products are traceable using certified recycled materials

The firm practices the circular economy by combining used and virgin raw materials resources, through altering the chemical composition of the used materials. The company has gone through the learning curve and has developed proprietary technology and processes, which the participant was reluctant to explain, and said:

'That is all I can show you. There is loads of other stuff going on, but all that over there is secret stuff, I am afraid.' P32

Since the waste material is input, there are two aspects of waste management. One is managing the waste, which is the used raw material resource for their business, also known as the core, because without the core, their business ceases to exist. Therefore, the company manages 'the core' with extreme caution, minimizing its wastage at every step of the recycling process, which is the second aspect of managing waste.

The company currently follows the mainstream notion of profit, of maximizing revenues. However, the interviewee's opinion is that profit should also include consumer benefits, as well as how much the company can save reserves of the natural raw material resources.

Other significant issues:

'...pretty startling, get a load of clever people about resource efficiency, bla!, bla!!, bla!!!. And then you get some senior environmental directors on board and say, oh let's pay thirty thousand to become a member of this club, and they all go and talk in Geneva and Paris about how wonderful it is. And our…my problem is that a lot of that is just kind of ivory tower sort of consultancy, sort of talk about theoretical models. But what we do is just grass roots delivering stuff…' P32

7. Summary of the firm 7

The seventh participating firm is a remanufacturer of replaceable automotive electronic components. This case company is an excellent example of turning adversity into an opportunity. They sensed the need for remanufacturing expensive electronic components during the 2007 economic recession, when it was essential for people to keep their cars on the road but not spend too much replacing a faulty part with a new one. These remanufactured expensive automotive electronic components[42] perform the same function, and come with a performance warranty allowing people to save money.

The interviewee is the chief operations officer with a background in electronics and commerce. He is responsible for UK operations, including developing the UK and European business.

[42] These components include ABS – anti-lock braking system, TCUs - transmission control unit, electronic control systems (electric motors, electro-magnetic valves), engine control module, and body control unit.

The participant understands the circular economy as being green, achieved through recycling, remanufacturing, and reusing electronic components again and again. His logic is that recycling and reuse lead to less waste, which in turn, gives rise to a greener environment. To him, a characteristic of the circular economy is green. However, he says that people are confused about the meaning of the circular economy, and in need of education for a more precise and distinct understanding.

The participant differentiates between circular cars and modular cars. He explains that a circular car is fully recyclable, i.e. all its components can be recycled, while modular car components are upgradeable but need not be recyclable[43]. A circular car allows the manufacturer to own the assets even after the end of its first life. A fully circular car has the potential to change consumer demand and, in turn, change the current ways of doing business within the automotive sector. For example, the design and colour of the car would not be an issue, as people would hire a car instead of owning them. The manufacturer would hold the vehicle and charge passengers on a per access basis. Many fewer people owning a vehicle would shrink the automotive industry, and there will be fewer cars on the road, which would lessen environmental pollution. As a result, such changes would impact on subsidiary industries associated with the automotive sector, and would compel them to align their resources and capabilities to the new market conditions.

> *'…but if it is a circular car used by other people as well, the shape does not matter anymore […] you pay for the service instead of having private ownership. As a part of the circular car they can make the car more environmentally friendly, they can look at the long term investment in the car, and they can take the car back in, update it, make the parts that you use in modular or circular and this way the car market would shrink…'P5*

The company faces the challenge of securing a steady supply of old used electronic components (also known as 'the core') and seeks to be a part of the supply chain of large OEMs, and is willing to change its operational processes to suit large OEMs. The company has developed its own proprietary methods, which gives the company an edge over its competitors.

The company brands itself as circular economy compliant because they are (a) remanufacturers, and (b) they have the policy to reuse the materials used for refurbishing the used electronic components, wherever possible. There is no formal waste management policy document, but it is under development.

[43] For example, the hydrogen fuel-cell car has a body structure made up of carbon fibre, which is not easily recyclable.

'…Then, luckily the recession came, sounds awful but when the recession came our business was still growing.' P5

As evident from the quote above, the notion of profit is maximizing returns on investments made.

8. Summary of the firm 8

The eighth participating firm is a remanufacturer of the mechanical automotive components. The founders started the firm in a garage in 1969 and since then they worked hard to establish it as a leader in transmission remanufacturing technology. Currently, the firm an authorized remanufacturer for several large OEMs, and offers consultancy services for designing for remanufacturing (DfR), which is part of the 'design for environment (DfE)' initiative. Also, it provides consultancy services for calibrating transmission equipment, sourcing end-of-life products, FMEA, and troubleshooting.

The interviewee is an OEM sales manager with an engineering background. His responsibilities include servicing global OEMs.

The participant understands the circular economy as extending the life of the product, which has reached its end. That is, finding a second use or repurposing products that have reached their end of life. He considers remanufacturing, refurbishing, recycling, and repair as part of a circular economy. Amongst all of these, for him, remanufacturing is the highest level of the circular economy, because remanufacturing allows for retaining maximum value, as opposed to plastics, which need bringing back to their raw material state before being re-cast or recycled into some other form for reuse or repurposing.

The participant seems to have more than one understanding of the circular economy. He links it to lean manufacturing and Six Sigma as they are also about driving out wastages.

'…everyone talks about Lean Manufacturing and Six Sigma and, you know, so it is constant improvement, constant measures, constant driving down costs and driving out waste, which again is all part of the benefits into the circular economy…' P8

He states that some people think the circular economy to be a charitable initiative, where profit-making is not the aim, and is looked upon as a negative thing.

'… think some people might view it as being almost a charitable sort of thing, where one is not allowed to make a profit because it is all about saving the planet. In reality, we have to make a profit to reinvest in future projects.' P8

The company has developed its robust rebuild processes, ensuring lower consumption of water, electricity, and raw materials required for instilling new life in a used part, which helps them to offer a performance guarantee against each remanufactured part. In Teece's(2019a)terms, robust rebuild processes are the company's signature processes that keep them ahead of their peers.

The firm faces a risk in maintaining a steady supply of used mechanical components, similar to that experienced by the electronic component remanufacturer. Therefore, the company follows a rigorous internal testing process, which makes the remanufactured parts withstand the durability tests. It is their hallmark and a source of business and market reputation. Their high-quality standards help them to recruit new clients as well as gain repeat business.

The company handles waste following ISO14001 certification and has internal performance metrics to control wastage of water and to improve energy utilization. The company also looks at the cost of quality. That is, they check twice or three times before a remanufactured part goes out of the factory, because if the low quality or faulty part is sent out, then it costs more to bring it back using the same value chain. In other words, the correct part going out results in saving time, money, and effort, thereby improving profit margins.

The company chases profit like any other business, often ploughing it back into the business to further advance the technology.

9. Summary of the firm *9*

The ninth participating firm is a University spin-out start-up company. They design and manufacture non-toxic compact heat batteries that store unused heat. The founders worked in partnership with the University of Edinburgh to develop 'phase change materials.' The 'phase change materials' when fitted in a battery can absorb heat, and then provide the stored heat wherever required. These batteries find their applications in electric and autonomous vehicles, for heating homes and social housing, and in industrial and commercial uses.

The interviewee is a business manager having a background in technical sales. His responsibilities include developing a global business for these batteries in the automotive sector.

Neither the interviewee nor the company understand the circular economy and had not heard the term before. Nevertheless, heat batteries align well with the circular economy because they saves energy.

The interviewee says there is an issue with the way a car functions. Firstly, a vehicle needs a large amount of electric energy to start its internal combustion engine. Then, sixty per cent of the heat energy generated while the car is running requires removal of the heat produced, for better performance of the vehicle. Whereas the engineers look for ways and means to warm the car or bus cabin, or to warm up the transmission to stop the rear tank freezing.

The company does not practice the circular economy in the strictest sense of the word because it is yet to start commercial production. However, the interviewee says that the company has plans to recycle each component of the battery.

> *'…When we get up to volume sales, we will need to meet the recycling directorates, which we can, as described earlier. Plastic can be recycled; recycle the heat changers, and the materials reused...' P26*

Similarly, the company does not have a waste management policy but plans to develop one.

The responses indicate that the company chases profit like any other mainstream business, i.e. to maximize returns on investments, evident from the quote, below:

> *'…last year I wanted to go back into the wild world of technology development but the owners gave me this rather exciting opportunity with a simple brief, just build a global automotive business for us.' P26*

The participant is unaware of the circular economy but seemed curious to know more about itthe circular economy because it aligns well with his business and the assigned task, to make the heat batteries project commercially viable.

10. Summary of the firm 10

The tenth participating firm is a materials technology consultancy established in 1979. The company offers a range of engineering services across industry sectors such as oil, petrochemicals, automotive, aerospace, marine, transport, and leisure. The engineering services include a wide range of activities, starting from research and development of new materials for production to helping firms in analysing and selecting materials. The company conducts corrosion investigations providing testing, fault analysis, and prevention methods.

The interviewee is the founder-director, with a background in metallurgical and civil engineering. His responsibilities include material selection, failure investigation, and development of new materials. Acting as an expert witness, he analyses cases in many litigation and insurance cases and leads the corrosion advisory services.

The founder-director understands the circular economy as making use of available materials not just once but again and again, by designing materials that can be quickly recovered and can be recycled indefinitely, which in turn, would help to conserve critical elements. The interviewee thinks the European Commission does not have any understanding of the circular economy. Though the company does not claim to be a part of the circular economy narrative or is a member of the CE100 club, it does practice the circular economy because it saves materials. The consultancy often advises its clients to use fewer materials, and repair rather than replace them with new, and design materials that are easily recyclable and recoverable. The interviewee is in favour of increasing household recycling by improving waste collection.

The participant believes in including the wellbeing of current and future generations reflected in the notion of profit.

11. Summary of the firm 11

The eleventh firm is the consultancy arm of the leading automotive trade association. The company started in 1996, helping major global manufacturers improve their manufacturing capability, business, and supply chain performances. It has a team of senior engineers with multi-sector manufacturing experience, by which the company develops competencies for removing wastages, thereby improving performances and instilling best practices

The interviewee is leading the consultancy services in the automotive sector. He has a background in mechanical engineering and is responsible for all categories of traditional automotive vehicles as well as off-road highway construction equipment such as the JCB-CAT.

The interviewee understands the circular economy in terms of reducing wastages and reuse by extracting the residual value from previously-used materials, either by combining or recombining processes. If any firm is not able to obtain the unused productive capacity of a resource, then they consider it a missed opportunity. They understand that remanufacturing is a circular economy process, applied only to a finished manufactured product. The engineers within the consultancy understand the circular economy from a waste reduction perspective. Furthermore, to reduce waste, the most common tools that engineers use are lean management, six sigma, and total quality management. So effectively they view the circular economy as a lean methodology, but there are very few who understand the circular economy term.

The interviewee explicitly states that the consultancy neither practices the circular economy nor intends to do so, as shown below.

'…certainly, within IF we do not comprehend any circular activity right now…' P4

However, the consultancy advises its manufacturing clients to practice lean manufacturing. A lean technique drives out wastes that are not readily visible in manufacturing processes. It involves evaluating methods and techniques, changing behaviours, and rethinking how to run the business. Considering the popularity of the circular economy, the company is thinking of renaming itself as a remanufacturing arm of the trade association. Still, there are not many takers for this proposition.

The interviewee says that the automotive sector being very cost-sensitive, manufacturers take handling waste very seriously, and they usually collaborate with their supply chains to bring costs down.

The notion of profit followed is similar to the ones supported by mainstream businesses, i.e. maximizing revenue and lowering costs. Reducing cost could be anything from reducing the workforce, or the energy costs, or could also include rationalizing equipment utilization.

Table 5-1: Summary of the seven steps for the automotive firms

Summary of the seven steps for the automotive firms											
Firms	**Firm 1-P1**	**Firm 2- P34**	**Firm 3-P42**	**Firm 4-P2**	**Firm 5- P47+48**	**Firm 6 - P32**	**Firm 7 -P5**	**Firm 8- P8**	**Firm 9- P26**	**Firm 10 – P30**	**Firm 11- P4**
The 7 Steps											
About the industry	Industry characteristics: Moderately dynamic market transitioning to a high-velocity dynamic multi-sided market structure with blurred boundaries and marked by next-generation competition.										
About the firm	A Premium OEM	A Fuel-efficient OEM	A Hydrogen fuel cell OEM	An Aluminum recycler	A Non-ferrous recycler	A Polymer recycler	An Electronic component remanufacturer	A Mechanical component remanufacturer	A Heat-batteries manufacturer	A Material consultancy	An Automotive trade association
About the manager	Mechanical Engineer	Masters in Automotive & Design Engineering	MBA	Masters in Environmental Engineering	Undergraduates	Chemical Engineer	Electronics Engineer with commercial background	Automotive Engineer Technician & Commercial experience	Commercial Experience	Metallurgical Engineer	BSc in Automotive Engineering
About understanding the circular economy	CE is recycling plus materials innovation.	CE is recycling plus design by altering chemical properties.	They do not understand the CE. However, they follow Prof. Paul Hawken's teachings.	CE is recycling.	They have heard of the CE but think it is recycling.	CE is recycling.	CE means remanufacturing, refurbishing, and repair.	CE means remanufacturing and recycling.	They do not understand the CE.	They understand the CE as recycling, reuse and using fewer materials.	They know the CE as zero waste, but do not advise their clients to adopt it.
About practising the circular economy	They practice CE as recycling. Use it for branding.	They practice CE as recycling. Use it for branding.	They plan to achieve sustainability, achieved through Servitization models.	They practice by creating close-loops with OEMs. Use the CE for branding.	They do not practice the CE.	They practice the CE by altering the chemical composition of polymers, use the CE for branding.	They practice the CE by remanufacturing used electronic automotive components.	They remanufacture used automotive mechanical components.	They do not practice CE.	They do not practice circular economy but advise designing products using fewer materials.	They do not practice CE but reduce wastages.
About handling waste	The tie-up with the Aluminium recyclers to reduce supply risks ensuring quality.	They manage wastes under the Green environment programme involving the supply chain.	Commercial production has not started, hence no formal waste management policy.	They manage waste under the global environmental programme. It is not linked creating closed-loops.	They deal with recycling wastes. No official waste management policy document available.	Waste management is monitored closely by senior management due to 'the core' supply challenges.	Routine procedures are in place to reduces wastages. However, there is no official waste management policy document.	They follow ISO14001. Develops Internal performance indicators to monitor and reduce wastages.	Commercial production has not started, hence no official waste management policy.	Not applicable.	Not applicable.
About the notion of profit	Maximising revenues protecting shareholders' interests.	Maximising revenues protecting shareholders' interests.	The notion of profit should internalise all operational costs, recognising natural and social value.	Maximising revenues protecting shareholders' interests.	Maximising revenues.	Maximising revenues.	Maximizing revenues.	Maximising revenues.	They are maximizing revenues, increasing market share.	Profit calculations should include wellbeing costs.	Helps to improve bottom-line performance.

5.2.3 Summary of all UK automotive firms' interviews

Table 5-1 above gives a snapshot of all the interviews. The UK automotive industry, though technically very advanced, is essentially a very conventional and conservative sector. It is price sensitive, and as margins continue to dwindle, the industry has become exceptionally costs-led. As a result, the responsibility of technology development is with Tier 1 and Tier 2 suppliers. Due to the nature of the product's liability, i.e., to safely transport human lives, the industry is highly process-driven and hierarchical.

The business environment is moderately dynamic, but with IT converging the automotive sector is potentially progressing towards becoming a highly dynamic turbocharged unstable business environment, because all large OEMs are in advanced stages of testing autonomous and electric vehicles. The autonomous cars are similar to 'mobile computers.' As a result, the market dynamism is in a new state, stemming from (a) the move by almost all large OEMs to lightweight their vehicles, and (b) the use of material technology to extract value from the same resource multiple times, in order to reduce production costs and mitigate supply risks. The market dynamism marks the emergence of the next generation competition.

The industry is undergoing consolidation, e.g., Tesla is creating its battery-charging infrastructure, and is underway for creating its ecosystem comprised of recyclers, remanufacturers, and tie-ins with garages, and is even talking to parking companies. Similarly, the other large OEMs are also creating their ecosystems.

The automotive firms are also witnessing external shocks from other non-conventional industries such as vacuum cleaner manufacturers, Dyson; and Uber, a US-based ride-hailing company, providing micro-mobility aerial transport systems within city limits. These new entrants are disrupting the already cluttered market. As a result of these external shocks and technological shifts, the boundaries of the automotive sector are blurring. The emergence of new market structures is marked by having multi-sided markets, creating confusion in understanding the circular economy. The multi-sided markets support 4R processes because all large OEMs have digitalized factory processes, which in turn, make the automotive industry ready for implementing the circular economy.

However, the understanding of the circular economy among the automotive firms is not uniform and is context dependent. That is, OEMs, metals, and non-metal recyclers primarily understand and practice the circular economy as recycling. Closing the supply chain loops is upon a need basis. The closed-loop explanation of the circular economy has further added to the confusion because it could be closed-loop, yet not lower the production cost or save the natural raw materials resource. The operational meaning of closed-loop for a recycler is bringing back the scrap or used material, reprocessing it, and supplying it back to the same client. Effectively, this becomes a private network safeguarding the interests of both parties involved, and a new way to block competition.

Similarly, the remanufacturers understand the circular economy as reusing, remanufacturing, refurbishing, and repair. The main drivers for practising reusing or recycling or remanufacturing materials are supply risks, and the need to reduce the cost of production for improving margins, including compliance to the EU Commission statutory and regulatory directives. Typically, recyclers and remanufacturers use innovative ways of combining and recombining used and virgin raw material resources for extracting the residual capacity from raw material resources.

For a material consultant, the circular economy is about reducing the use of primary metals by creating new materials. For the consultancy arm of the trade association, the circular economy does not exist as they follow the lean management, Six-sigma tool, to remove wastages from the processes.

All eleven participants expressed the view that firm managers and the general public do not understand the circular economy and are unable to relate it to their business needs.

Almost all firms have understood that the 'circular economy' term is a buzzword and therefore use it to their advantage. Several participants acknowledge the involvement of vested interests behind the sudden popularity of the circular economy.

All firms studied have their signature processes developed in-house. They usually achieved this either by combining used and virgin raw materials, or through innovative design, or by designing creatively new raw material properties according to the functionality required.

Some interviewees highlighted a few contradictions. E.g., aluminium recyclers favour closed-loop recycling as it secures their supply of used or scrap aluminium. Increasing the recycling content in recycled aluminium to lower their production costs warrants an increase of scrap generation, which is not in the interest of the OEMs. However, the OEMs, having collaborated with the aluminium recycler to get back their scrap, do not bother increasing scrap generation.

The aluminium recyclers look for other sources of used aluminium to increase the recycled content in its production. Beverage cans are an excellent source of used aluminium. However, the recyclers are not sure about the manufacturing process followed by the beverage can producer, and whether they use virgin aluminium or use coal fire to heat their furnaces for manufacturing cans. Though these are important issues for environmental sustainability, neither the beverage can producers nor the recyclers consider it worth following and finding out this level of detail. On the contrary, if an aluminium recycler is increasing the used alumina in producing aluminium sheets, then its customers start questioning the quality, most of the time motivated by its competitors. As a result, the recycler fears losing its customers as they continue to use virgin aluminium, which is cheaper but requires enormous energy for extracting it from its ore, bauxite. It is a cartel market.

Similarly, ferrous and non-ferrous recyclers have to face the whims and fancies of the compliance officers. Sudden change in waste regulations without prior notice to the recyclers makes their investment redundant. As a result, the recyclers look for ways and means to compensate for the loss.

All firms studied handle wastes as a compliance activity; however, the approaches differ. E.g. car manufacturers and metal recyclers manage their waste mostly under the environmental management program. Polymer recyclers have their own proprietary waste managing processes, which help them to compete in the secondary materials markets. For remanufacturers, it is about complying with IS14001 and IS16949.

The profit motive of almost all firms investigated is primarily about maximizing returns on investments. Only the manufacturer of the hydrogen fuel cell car and the material consultant view profit not only for maximizing returns but also for conserving the reserves of raw material resources, wellbeing, and generational equity.

5.3 Inner – Nest Case 2: The group of UK Information Technology firms

Eight participants from the UK Information Technology firms participated in this research study. The breakdown of the eight participants is as follows. There are (a) two participants from multinational companies manufacturing laptops, desktops, printers, and computer accessories, (b) two participants from multinational telecommunications firms, (c) one participant each from (d) 3D manufacturing, (e) digital automation arm of the World's largest technology company, (f) a software development company, and (g) the UK's tech sector flagship trade association.

5.3.1 Trends in the UK IT sector – A collective view of the participants'

Information Technology (also known as the tech sector) is creating disruptions in different markets across industries. The digitalisation and digitization of factory processes primarily drives the market disruptions. Such factories are also known as 'Smart Factories' and are a part of Industry 4.0.

Digitization involves converting any information into digital format. That is, data is grouped into distinct units called bits that can be separately addressed, usually in groups of bits called bytes. Whereas digitalisation is a process of leveraging digitization to improve business processes. For a business enterprise, digital modelling has become a standard approach for developing new product design and manufacturing. In a digital world, physical material things can sense and make decisions without human intervention, which is referred to as Artificial Intelligence, enabled through machine learning language. All of this means that businesses are becoming 'digital enterprises' resulting in their increased flexibility and capability for having efficient production processes, which help to lower the consumption of raw material resources as well as reducing the time to market. There is intense competition to come up with innovative technologies that increase resources productivity. In the backdrop of the tech sector's technological innovations, there is a burgeoning sub-sector, which operates on leasing and extended warranties operationalised through processes such as remanufacturing, reuse, refurbish, recycle, and recover. It creates multi-sided markets. As a result, the tech sector business environment is highly dynamic, as firms compete either through differentiating on technology, or based on services they offer, or both.

The warranties offered by the remanufacturing and refurbishment sub-sectors give rise to a range of repair networks. Effectively, this gives rise to two different modes of operations. These are (a) regional hubs for repair and remanufacturing, which are operated either by manufacturers themselves, or the use of contractors in local geographies to carry out activities on their behalf. Secondly, there are (b) third parties repair networks, i.e. walk-in repair centres or a kind of consolidated manufacturing site for repair. The remanufacturing and refurbishment sub-sectors impact on the primary IT market in a variety of ways, further increasing the competition.

All such developments are making the tech sector very attractive for investors, because the long-term return on investment in digital technology is 6.7 times that of investments in a non-digital technology, and the growth of the digital economy is 2.5 times that of global GDP.

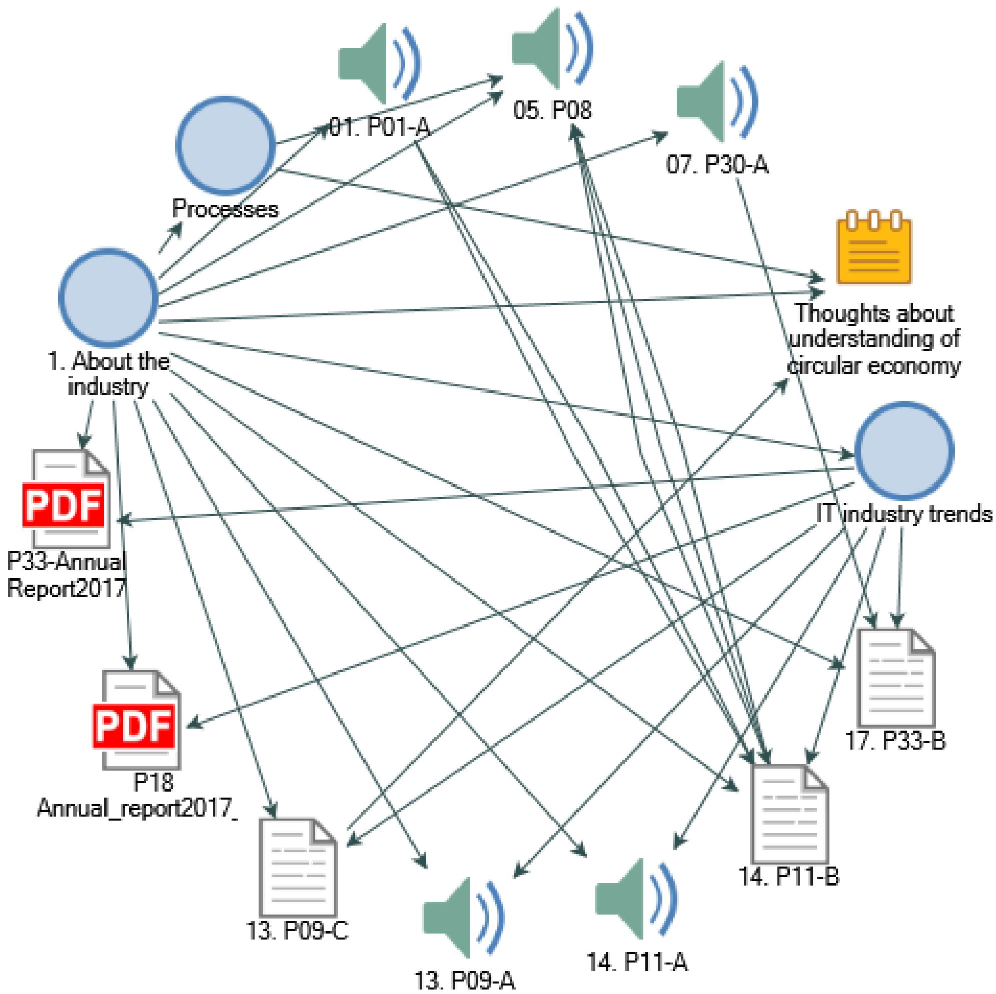

Figure 5-5: Coding map showing participants' responses for trends in the IT industry

5.3.2 Details of the investigated UK IT firms

12. Summary of the firm 12

The twelfth participating firm is a US-based multi-national Information Technology company manufacturing PCs, printers, and mobile devices, and offering managed services. Their corporate vision is to create technology that makes life better for everyone everywhere. The company is a member of the CE100 club.

The interviewee is the UK-based director of sustainability operations, leading the company's circular economy programme. She has a doctorate in environmental engineering. Her responsibilities include developing business for the printer division and managing and increasing the recycling and repair activities worldwide.

The participant understands the circular economy as reducing the consumption of materials, reusing and recycling equipment such as printers, cartridges or other components. The participant's understanding of the circular economy is to decouple revenue growth from the consumption of raw materials resources by reuse, recycling, and repair. The skewed perception of the circular economy demonstrates that the participant is either unable to present a coherent understanding of the circular economy, or recycling and repair activities take precedence in her knowledge of it.

> *'…Thus, yeah, a circular economy is about recycling, but in my view circular economy if you remember, I said it was about doing-- in effect doing more with less. So it is decoupling revenue growth from the consumption of stuff, that is what recycling is, is that we reduce our purchase of virgin materials by reintroducing secondary materials.' P11*

However, the firm primarily practises the circular economy in a series of steps such as reduce, reuse, recycle and recover - all of these steps are part of its environmental protection and sustainability programmes. Such programmes also include reducing GHG emission, use of water and designing a product(s) for sustainability and extensions of their earlier recycling programmes. Effectively, there is nothing new that the firm does with regards to the claim made of practising the circular economy. The interviewee also declares that the circular economy is not new to them.

She considers a circular economy and sustainable development (refers it to as sustainability) as two separate entities. According to her, in a circular economy, the economy part is more pronounced, and it is business-orientated, whereas sustainability is not.

The interviewee shared two crucial pieces of information regarding the underlying mechanisms driving the interest in creating closed-loops.

The first is that big corporations do not intend to lower their consumption of products, yet they want to project themselves as championing the cause of reducing waste. So, they enter into different types of collaborations and leasing models distancing themselves from direct use.

‘Philips is our biggest leasing customer, and we have eighty-two thousand leased assets with Philips. Philips wants a different story from us about our collaboration with them […] they very big into the circular economy and one of the founding members of the Ellen MacArthur Foundation…’ P 11

Secondly, to substantiate customers’ collaboration, the company obliges its biggest customer by introducing the product-as-service concept, thereby making ‘ink-as-service’. It is a subscription-based model that helps to recycle used cartridges, benefitting another big customer by allowing them to replace their empty cartridge with an ink-full of the reusable cartridge at a much lower price. In this manner, the company can get back its raw material resources at the end of the product’s life without contamination, while having a captive customer base that ensures a steady revenue stream. So, this is a circular economy for them. From this perspective, the interviewee claims that they practice the performance economy advanced by Prof. Stahel.

The company also manufactures ink cartridges using used PET bottles. The process uses both virgin resin as well as recycled resins. It is a tricky process because the mixture of used and virgin resin has to be in the right quantity; otherwise, it would result in a chemical reaction between the cartridge and the ink. Therefore, the company develops innovative ways to alter the chemistry of polypropylene. Resin formulators often develop such innovative ways of ensuring the correct balance. Such activities were carried out earlier under the ‘sustainability programme’ called ‘Planet Partners’. So, nothing has changed, except the name. Rebranding previous programmes under the circular economy helps the company to improve its image as a company that does the right things.

‘But for the average customer, does it matter? They just expect us to do the right thing.’ P11

These programmes, when carried out in a third world country, are called corporate social responsibility programmes, driven by the need to get PET bottles, to mitigate supply-risks. The company manages waste under its environmental policy. The interviewee did not hesitate to claim that theirs is a capitalist model, focusing on maximising profit and protecting shareholders’ interests.

'[ours] is a product of capitalist society. How much profit is enough profit? I do not know? We have shareholders. The answer would be there is no end to profit, and always there must be profit.' P11

However, the participant is aware that the circular economy aims to decouple revenue growth from raw material resources consumption. So far, the company is not able to understand how it can make more money by selling fewer products when the risks are enormous, i.e. an $80 billion-dollar supply chain with a hundred million products going out every single year.

13. Summary of the firm 13

The thirteenth participating firm is a US-based multinational computer technology company, which was started in a garage by an entrepreneur[44]. It manufactures Personal Computers, PC monitors, laptops, servers, data storage devices, network switches, computer peripherals, HDTVs, and distributes electronic hardware. The company is a member of the CE100 club.

The interviewee is head of environmental affairs with a commercial background. His responsibilities include promotion and support of asset resale and recycling programmes and implementation of WEE and Batteries directives within the UK and other EMEA countries.

The interviewee understands the circular economy as keeping the product(s) and raw material resources in circulation as long as possible, either with or without intervention. As the circular economy encompasses several things, the company has preferred to focus on one or two main things, one of which is recycling. However, the interviewee thinks the circular economy to be a new term assigned to things that they were already doing, and it aligns everyone under one umbrella.

'…basically the circular economy is a new term for pretty much, for many things that we were already doing. I think it is a new flag for everybody to align under…' P49

The company views sustainability to be a part of a circular economy, i.e. sustainability to be a component of the circular economy.

The company combines virgin material with used material to extract the residual value, and save the use of the critical resource. In practice, a circular economy to them is about reuse, recovery and recycling.

[44] 'Image in the mind of an entrepreneur'.

Under the circular economy practice, they created a global reverse supply chain in collaboration with their suppliers, which helps them to recover the gold from their printed circuit boards (PCBs) and plastics for reuse. They term this operation as asset recovery or closed-loop gold and closed-loop plastics. It is a close network of operators. One among the operators buys the PCBs locally at the lowest price before shredding, and before it is bailed with other materials and enters the global supply chain. They buy these PCBs in China because all wastes typically end up there. These materials then go to another operator in China who recovers it and give it to a third operator, who sends it back to their manufacturing plants. So, this is how the company creates closed-loop supply chains.

The company is always on the look-out for an opportunity to create circularity for raw material(s) that are either in scarce supply or critical for their product manufacturing - this helps to save critical virgin raw material resources.

Their waste management policy has not changed, albeit with a few changes in the supply chain such as introducing segregation of plastics by partners before the plastic waste goes to a disposition agency. They manage waste according to the compliance regulations for e-waste. They have issues with the government.

The firm believes in maximising profit, and for them the circular economy is an excellent vehicle for achieving it.

14. Summary of the firm 14

The fourteenth investigated firm is a UK-based telecommunications services provider. The company's product offerings include fixed-line services, broadband, mobile and TV products and services, as well as managed networked IT services. It is a signatory to the UN Global Compact principles and contributes to the UN Sustainable Goals and has a global footprint in 180 countries. The company is a member of the CE100 club.

The interviewee is a principal consultant for sustainability, having an academic background in environmental engineering and a specialisation in policymaking. He is responsible for developing environmental strategies, accelerating the move towards a low carbon economy by embedding the circular economy principles in the business.

The participant understands the circular economy to be a regenerative process achieved through reuse and recycling of materials and renewable energy. For him, the circular economy is about achieving zero-waste.

> *'… I do not think if you were to present the circular economy as a concept to project managers within [XX] that they would necessarily come up with all of that...' P14*

The term 'circular economy' is not accessible within the business as the managers do not understand it, except product managers. The product managers understand the circular economy because they would have either reused or repaired a piece of equipment for reuse. It means for them that the circular economy is about re-use, repair, and recycle (if possible).

The participant thinks sustainability is much broader in scope, while the circular economy is restricted to environmental sustainability only. For him, sustainability is more significant than environmental sustainability, and includes aspects of social and economic sustainability, and both these are very closely intertwined. The firm does not have any signature processes developed to mitigate resource supply risks or price fluctuations.

The company has separate official waste management and environmental policies. Waste management helps the company to recover plastic and precious metals from the end of life telecom equipment and accessories. The firm produces an annual sustainability report.

Profit is about gaining value, which is more than monetary profits. A right way forward is to ensure that people understand the value of waste.

15. Summary of the firm 15

The fifteenth participating firm is a leading Chinese global provider of information and communications technology (ICT) infrastructure, smart devices and solutions. It is the largest telecommunications equipment supplier to the previous case company. offering integrated solutions across four domains, namely telecom networks, IT, smart devices, and cloud services.

The interviewee is a deputy managing director based in the UK, with a background in product management. His responsibilities include maintaining the firm-client relationships, managing client expectations and transforming activities in the telecommunication service provider.

The participant understands the circular economy as recycling on steroids.

'…I think I described it to you the other day as recycling on steroids.' P18

Accordingly, for him, the circular economy challenges the assumption that a product has a definitive lifecycle and is often just for a single use or for a single customer group. For him, the circular economy seeks to extend the life of materials used in a product, and potentially extends the life of the product as well through multiple uses and in multiple cases. He acknowledges that the circular economy has taken sustainability to a new level. However, people within the organisation do not understand it. Also, the interviewee was not aware that China had already passed circular economy legislation.

For the participant, the elements of the circular economy include design, multiple customer usage, process, distribution, logistics, marketing, the customer, and the entire product life cycle.

The circular economy is practised within the company as reuse, repair, and recycle activities, since the shelf life of the electronic component is around 7-10 years. They redistribute electronic equipment and components across geographies for multiple uses. In other instances, the old types of equipment that have reached their end of life undergo disassembly for reusing those components that are fully functional - they term this process as partial manufacturing (HI&Co, 2017). The firm manages waste under the environmental protection programme. It includes increasing resources utilization in production facilities, logistics centres, and laboratories. Also, managing waste includes reducing water consumption and lowering GHG emissions.

The participant feels that accounting principles need changing for a circular economy environment. It should include a terminal value for a resource that has exhausted all its residual capacities. The terminal value determines the value of the product because profit depends upon the extractable residual capacities of a resource. However, the notion of profit that is followed is maximising returns.

16. Summary of the firm 16

The sixteenth investigated firm is a Japanese multinational based in the UK, offering a full range of additive manufacturing services including real-time 3D manufacturing and consultancy. It includes designing, prototyping, sampling and manufacturing across a range of sectors, such as consumers goods, industrial, electronics, and prosthetics.

It also offers web-based 3D manufacturing services, where customers can upload their data giving specifications of their choice of raw materials and printing technology. The company then develops a prototype without the physical movements of people and materials.

The interviewee is regional sales manager for 3D additive manufacturing services, with a commercial background. His responsibilities include developing business for 3D manufacturing units within the UK and European regions.

The participant understands the circular economy to be promoting zero to landfill, that includes reuse and recycling processes.

'…circular economy is about zero-to-landfill; recycling and reuse…' P3

For them, a circular economy is about increasing a resource's efficiency by recycling products and harnessing recycled resources.

When asked if he could describe how the circular economy is at work in their company using their famous Comet Circle™, he said:

'…Though [XXX} have taken 3D manufacturing, there are some definite challenges for it to become a part of the Comet Circle™… ….'' so Comet Circle focus is on the replenishments and the recycling of toner, ink and inkjet technologies…' P3

From this statement, we can understand that 3D manufacturing does not have a direct link with the circular economy. Although 3D manufacturing being an additive process and not a reductionist process (as in the case of manufacturing) does help in saving the raw materials resource because there is no waste generation. From this perspective, 3D or additive manufacturing supports the circular economy. Comet Circle™ concerns recycling alone, using its supply-chain partners across Europe to bring back the recyclate.

It is challenging to recycle powders used for 3D manufacturing, due to the absence of appropriate technology, as opposed to polymers that are fit for recycling due to their chemical composition.

Powders cannot be recycled back into a crystalline form as compared to the polymer pellets, which can be used in injection moulding but not in additive manufacturing.

3D manufacturing helps in compressing time, i.e. by reducing time to market a product or reducing the downtime required for carrying out repairs. The time compression diseconomies concept is significant in strategic management for achieving competitive advantage. It means ‘compression time’ using 3D manufacturing will no longer result in diseconomies as argued by Dierickx and Cool(1987; Dierickx and Cool), possibly helping to achieve competitive advantage quicker.

Another distinctiveness of 3D manufacturing processes such as SLS- selective laser sintering, is allowing a combination of old and new resources, which in turn results in a better or similar quality of products, and helps in conserving the raw material resources. However, not all raw materials used in 3D manufacturing can be easily recycled. The company manages waste under environmental policy. Profit is chased not only to make money but is also invested back in business and people.

17. Summary of the firm 17

The seventeenth participating firm is the digital division of a Germany-based multinational. They are the world’s pioneers in electrification and automation. The company’s products and service offerings include a comprehensive portfolio of hardware and software products, enabling the integration of processes and automation. This digital division has developed a ‘product life cycle management (PLM)’ software that helps in representing the entire physical value chain digitally, which is key to transforming and improving resources productivity. The PLM software provides an extensive and unique portfolio of software tools and drives industrial automation. Another software, ‘Totally Integrated Automation’, ensures efficient interoperability of all automation components. It enables significant time and cost savings in engineering processes on shop floors The firm has spent 13-14 billion euros to acquire five software companies in the last five years, and is in the process of building a wholly digital environment.

The interviewee is a senior manager with an academic background in electricals and electronic engineering. He is leading the automation drive within the UK’s SMEs, focusing on automotive, aerospace, food and beverages, and pharmaceutical sectors.

The participant understands ‘digital economy’ but not a circular economy. He thinks a circular economy is morally based. His understanding of the digital economy is from the perspective of industry 4.0 and digitalisation of commercial transactions; since industry 4.0, i.e., digitalisation of the manufacturing processes, allows simulation of the factory processes, which helps in reducing the use of natural raw material resources overlaps, or supports a circular economy. He knows recycling may or may not be cheaper than using natural raw material resources. Hence, he understands the circular economy to be morally based.

> *'…It is difficult – the circular economy, is it moral based, or is it economically based? Because to recycle something may or may not be cheaper than actually using the raw product[...], I think, for the circular economy to work, it has to be government-sponsored.' P33*

He also links the circular economy to lean management techniques, such as Six Sigma or continuous improvement, as digital simulation allows reducing wastages in processes.

According to the participant, closed-loop is about, 'one source of truth'. It means, in a digital version of a factory, that each product is fitted with sensors to enable tracking. In this digital environment, the data is brought back into the system to get a full picture of the product. Thus, enabling a single digital model of the product, and in other words, enabling 'one source of truth' through closed-looping.

Digital automation of the factory supports all the aspirations of the circular economy. Hence, though not directly but indirectly, the company practices the circular economy through digitalisation and simulation, thereby lowering the consumption of raw material resources. In 4Rs terms, the company focuses more on reducing the use of natural raw material resources.

The waste management policy of the company includes sustainability of the products used, the sustainability of energy used, and carbon neutrality in product design.

The notion of profit is not significantly different from the mainstream. However, the participant recognises that sustainability of employees and workforce is equally important to consider, as much as we consider the sustainability of forests and the sustainability of productivity. The company has joined the Global Business Initiative on Human Rights, which is about advancing human rights in a business context, achieved through cross-industry peer learning, outreach and capacity-building, and by informing policy. The company is also a part of the European Business and Human Right Peer Learning Group of the Global Compact Network.

18. Summary of the firm 18

The eighteenth participating firm is a US-based multinational software developer, and a leader in developing 3D design, engineering, and entertainment software. They were the first to introduce the AutoCAD software in 1982. Since then, they have developed the broadest portfolio of 3D software for global markets. These software products help in designing, visualizing, and simulating ideas, even before creating or building the product(s), and finds their application across different sectors such as manufacturing, architecture, building, construction, and media and entertainment.

The interviewee is a senior manufacturing industry manager with an academic background in industrial design, and a master practitioner in neuro-linguistic programming. His responsibilities include helping SMEs to address their manufacturing and design challenges and also acting as an interface between the company and its clients. The role is a mix of advisory and sales. He is also part of the British Manufacturing initiative.

The participant confessed of not understanding the circular economy and says he has come across the term only after taking up his current role. Whatever knowledge he has about the circular economy is because of his product development background, which makes it compulsory for him to answer questions regarding (a) a product's functionality and (b) the features required before designing a product. Therefore, his understanding of the circular economy stems from design thinking and he describes it as the process of 'cradle to grave design thinking' or, 'cradle to grave, and beyond'.

> *'My view about the circular economy is from a sustainability point of view, what is the full lifecycle analysis of the product…And if you look beyond that when you dismantle the part or maybe you know, reuse some of the components or something like that, does that create any other businesses or industries that do not exist today, that add value to our kind of working life and personal life' P49*

The participant considers sustainability to be a part of the circular economy as according to him, sustainability is about carbon footprint and recycling, whereas a circular economy is broader than sustainability.

The company does not practise the circular economy. Instead, they follow the processes involved in design thinking, and as a result they conduct a life-cycle analysis of a product before designing it. The conservation of resources is through flexible manufacturing, which is not a circular economy. Flexible manufacturing means having the ability to use hybrid manufacturing technologies, i.e., additive, subtractive, and automation or robotics, in the right blend. Moreover, all of this is possible through digitalisation, which is central to flexible manufacturing.

However, the company reuses its designs, which means the company makes standard designs for components that are fast-moving to avoid designing every time. They use life-cycle analysis to understand the missing links in the processes while developing an integral solution. It also helps them to identify and eliminate wastages in the processes.

The firm manages its waste under the environmental policy and is committed to power its Cloud service using one hundred per cent renewable energy by 2020. The company focuses mainly on four UN Sustainable Development Goals namely (a) affordable and clean energy [Goal 7], (b) industry, innovation and infrastructure [Goal 9], (c) sustainable cities and communities [Goal 11], and (d) responsible consumption and production [Goal 12], through its products, operations, and philanthropic activities.

The firm's notion of profit is about maximising revenues. However, the participant argues that if metrics are in place to measure employees' satisfaction and wellbeing, then a benchmark can be created for a circular economy. Additionally, if businesses and governments can work together to introduce some interventions and mechanisms that support moving away from a traditional profit model to a circular profitability model, then, it would help to decouple economic growth from resources use.

19. Summary of the firm19

The nineteenth participating firm is the UK IT sector flagship trade association. It has a membership of over nine-hundred IT companies, ranging from FTSE 100 to innovative start-ups. The trade association's vision is to make the UK a leader in the development and use of digital technology, to benefit the economy and its citizens.

The interviewee is head of the environmental and compliance programme. She has an academic background in environmental sciences. Her responsibilities include helping the association's members deal with the latest statutory compliance issues, and also formulating the environmental policies in liaison with the government, protecting the interests of the IT companies. The environment and compliance programme covers issues such as the circular economy, eco-design, extended producers' responsibility (EPR), and climate change policy.

The interviewee views a circular economy as a new name given that recycling, remanufacturing, leasing, and extended warranties are centuries-old practices. She says that circular economy is a term coined by environmentalists and re-plastered on to old practices. According to her assessment, the circular economy is not very popular amongst businesses within the IT sector.

She understands the circular economy as keeping the raw material resources or components in productive use for as long as possible; in a manner that the products can be recycled, reused or recovered - choosing non-hazardous materials only after considering their environmental impacts so that these materials can be recycled multiple times.

According to her, a large number of tech-firms understand a circular economy as recycling. However, a few have chosen to use the circular economy to manage their environmental issues and achieve climate change targets. She says that the linking of the circular economy performance to recycling targets is a result of lobbying by the waste sector's giants in the corridors of powers.

She informs that businesses understand resource efficiency and resource productivity better and relate to it much more than the circular economy. Her idea of resource efficiency is about limiting reliance on virgin material, i.e. using material that we have as effectively as possible.

> *'… I think what is happening now is that the sustainability leads are presenting kind of new opportunities in a broader context, part of that I think is around the resource security agenda. I think it just needs to recognise that there is a range of new and different options that can leverage competitive advantage and reflect on those. It might not be for every company, but I think it remains largely the gift of the sustainability manager to push those messages within the company. Unless it is a disrupter.'* P9

The interviewee says that the IT firms engage in all activities, such as reducing the reliance on critical raw material resources and recycle, repair, remanufacture, and recover wherever possible. They dispose of their waste following the 'Waste Electrical and Electronic Equipment Directive (WEEE).' She credits the tech-firms for having given the world the ground-breaking technologies to address the resource security agenda. These technologies include but are not limited to machine learning, artificial intelligence, additive manufacturing, 3D printing, big data, RFID, and 5G spectrum that enables the industrial internet of things. From this perspective, the tech sector is a significant enabler of the circular economy, helping to convert waste into resources again.

Most of the IT companies follow the mainstream notion of profit. However, she thinks there should be a paradigm change in how companies view raw material resources while in use, or when they are in stock, and the value they attached to them. Current accounting principles need a complete makeover, and this calls for other research.

Table 5-2: Summary of the seven steps for the IT firms

Summary of the seven steps for the IT firms								
Firms	***Firm 12 P11***	***Firm 13 P49***	***Firm 14 P 14***	***Firm 15P18***	***Firm 16 P3***	***Firm 17 P33***	***Firm 18 P45***	***Firm 19 P9***
The 7 Steps About the industry	Industry characteristics: It is a high-velocity dynamic multi-sided market structure having blurred boundaries marked by next-generation competition.							
About the firm	US-based Computer OEM- Member of the CE100 club.	US-based Computer OEM. Member of the CE100 club.	The UK based Telecommunications service provider. Member of the CE100 club.	Chinese MNC, based in the UK, provides ICT infrastructure and the most extensive telecom equipment, supplier.	A Japanese MNC, based in the UK, provides 3D manufacturing and additive manufacturing consultancy services.	A German MNC based in the UK, provides complete digital automation solutions to large and SMEs.	US-based MNC software developer. They are pioneers in developing AutoCAD software for global markets.	The UK's IT Sector trade association.
About the manager	PhD in Environmental Engineering.	Commerce-Business development	Environmental Engineer has specialisation in policymaking.	Specialisation in product management.	Commerce and Sales.	Electrical and Electronics Engineer.	Industrial Design Engineer, having masters in neuro-linguistic programming.	Bachelors in Environmental Sciences.
About understanding the circular economy	CE is recycling and doing more with less - introduced ink-as-service business model.	CE is about recovery, recycling, reusing.	CE is about recycling and a regenerative process.	The CE is about recycling put on steroids.	The CE is about zero-to-landfill. Increasing resource's efficiency by recycling.	The CE is morally based.	Does not understand the CE. However, views the CE from a design perspective.	The CE is a new name given to recycling, remanufacturing, leasing, and extended warranties.
About practising the circular economy	Practised as recycling and closed-looping using own supply-chain network.	They have created global reverse logistics for recovering Gold for PCBs.	They practise the CE as recycling and using components extracted from used equipment.	The CE practised as recycling, reuse and repair activities.	They do not practise the CE. Offers 3D manufacturing that supports the CE.	They do not practice the CE. However, they provide the simulation of factory processes, which help in saving raw materials resources.	They do not practice the CE. However, they considers the availability and functionality of raw materials resources before designing a product.	IT firms engage in reducing the dependence of critical raw materials resources. Mostly engage in recycling.
About handling wastes	Global policy to follow reduce, reuse, and recycle.	Waste management policy follows reuse hierarchy.	They have an official waste management policy and environmental policy for managing waste.	They manage wastes under environmental protection programme.	The raw materials used for 3D manufacturing are not fit for recycling except SLS.	Reduces wastages in processes through simulation	The company resues its designs. Most of the designs arestandardised for saving time and reducing the use of creative resources.	Most IT firms do not understand WEEE compliance.
About the notion of profit	Maximising revenues and protecting shareholders' interests.	Maximising revenues and protecting shareholders' interests.	It is about maximising revenues. Also, ensuring people understand the value of waste.	Accounting principles needs changing - the inclusion of the terminal value of the resource for determining profits.	Reducing costs and maximising revenues.	They maximise revenues by reducing the cost of production.	They are maximising revenues. However, the participant thinks profit should also include the wellbeing of employees.	Most IT firms maximise revenues. However, Accounting principles needs changing.

5.3.3 Summary of all IT firms' interviews

Table 5-2 above gives a snapshot of all the interviews. The representative sample, which includes eight business cases, captures most of the circular economy activities within the traditional niche of the IT sector. The sample cuts through a cross section of firms to include computer manufacturers, a telecommunications service provider, a telecom equipment manufacturer, a FTSE100 company providing factory digitalisation transformation services, a leader in software development, and a trade association.

The participants revealed that the IT sector is witnessing creative disruption due to rapid technological advancement, thereby making the business environment increasingly turbulent and unstable. It, in turn, compels firms both within and outside the IT sector to rethink their business models, as manufacturing units transform themselves into digital factories, allowing simulation of the manufacturing processes before going into the live production mode. The new ways of manufacturing help to not only save virgin raw material resources but also to increase resources productivity. Also, digital factories help in reducing waste as well as dependence on virgin raw material resources. The digital factories result in connected ecosystems e.g. smart manufacturing, Industrial Internet of things; and these infrastructure facilities act as enablers for the circular economy. This facilitation gives a circular economy an edge over sustainable development in addressing all the three dimensions (environmental, economic, and societal benefits). However, most participants do not have a clear understanding of the circular economy. At this juncture, any IT processes or systems architecture that reduces waste or conserves raw material resources inadvertently goes under the circular economy banner, which causes further confusion about the knowledge of the circular economy within the organization.

The participants' lived experiences demonstrate that their understanding of the circular economy is context-dependent, as they link their knowledge either to sustainability, recycling, or the waste hierarchy. Some participants understand the circular economy as decoupling revenue growth from the consumption of materials. In contrast, others understand it as an economy that is regenerative by design, while still others understand it as recycling on steroids, and reengineering of products, and zero to landfill. Some firms understand the circular economy as about doing more with less. Still others understand digital economy to be synonymous with the circular economy, and interpret design thinking as a part of a circular economy or undertaking life cycle analysis or closed-looping as part of the circular economy approach. For some, a circular economy is morally based.

Firms that are members of the CE100 follow the Ellen MacArthur Foundation definition of the circular economy. In contrast, others follow the definition by Prof. Stahel, the proponent of performance economy, while others follow life cycle analysis. In contrast, a few do not follow any of these but consider technological development as an opportunity to reduce production costs and improve their profit margins. For most, the circular economy is an old concept. Some understand the circular economy as a reverse supply chain. A few believe that the circular economy is a term coined by environmentalist and plastered on to the manufacturing activities; therefore, the environmental perspective of a circular economy is more pronounced. However, all unanimously agree that understanding is not uniform within an organization or across the sector.

Out of the eight firms investigated, four firms (about fifty per cent) use a circular economy as part of their branding strategy, promoting their business as an ethical brand.

On the static-dynamic continuum, as in figure 3-2 in chapter 3, the IT sector falls on the dynamic side of the continuum. It means that the IT sector is ready for decoupling economic growth from resources use - in other words, increasing resources productivity, thereby reducing dependence on virgin resources, as well as lowering waste generation.

Most of the participants' firms usually practice recycling or the 4Rs of the waste hierarchy and describe themselves as implementing the circular economy. The two significant developments reported by participants from computer manufacturing firms are (a) mostly all firms develop their signature processes by combining 4R processes in different permutations and combinations for competing in their niche, and (b) the firms look for incremental innovations, which at times leads to disruptions in the market.

Out of eight firms investigated, six firms view sustainability as a broad term, as compared to the circular economy. In comparison, two firms view sustainability a sub-set of a circular economy. All consider the circular economy to be business-orientated as opposed to sustainability.

Most of the interviewee's firms manage waste under environmental protection policy. Only one firm has a separate waste management policy to deal with waste.

The participants were reluctant to share their ideas about the notion of profit. However, most of the interviewees considered the circular economy as a way to reduce their production cost, thereby improving profit margins. A couple of participants were vocal and accepted that the circular economy does help them improve their profit margins.

All eight firms chase profit, intending to maximise returns, but two firms acknowledged the need to consider maximising returns in the context of the circular economy to include the well-being of employees. They highlight the need to rethink accounting principles to include recycling activities, to enable products and raw material resources to stay on the balance sheet of the parent company, even while the raw material resources are in use at other sites. They suggested the need to consider the terminal value of the raw material resources to be factored in to manufacturing cost.

5.4 Outer – Nest Case 3: The group of UK Government Agencies

Thirteen participants from eleven different government departments and agencies from England, Wales, and Scotland participated in this research. Additionally, two participants from European regions, i.e. the Netherlands and Croatia, also participated. All fifteen interviewees were involved with their respective government's circular economy initiatives.

5.4.1 Roles and responsibilities of the participating UK Government agencies

The Government has the legislative and regulatory authority and is responsible for policymaking to safeguarding the environment, protecting, and building the country's reserves of the natural raw material resources.

In the U.K., DEFRA is the nodal governmental agency for protecting the environment and natural raw materials reserves, including food security and rural affairs. The circular economy is also within its remit. DEFRA's delivery partners for the circular economy are 'The Waste and Resources Action Programme (WRAP), the Environment Agency, and Local Partnerships. Also, London Waste and Recycling Board, a statutory body funded by WRAP, and the London Green Fund, indirectly fall under DEFRA.

The other department in England, which is not under DEFRA, is Innovate UK. It is a non-departmental public body funded by a grant-in-aid by the UK government. The circular economy falls under the manufacturing, materials, and mobility division, and pursues circular economy research and development.

Similarly, within the devolved Welsh Government, the Waste Strategy Branch that functions under the Department of Natural Resources, handles the circular economy programme. The Welsh government also delivers its Waste Programme partly through the Local Partnerships Company owned by Local Government Association, HM Treasury, and the Welsh Government.

The Scottish Government created a not for profit environmental company, Zero Waste Scotland, separating it from WRAP and DEFRA. Zero Waste Scotland informs policymaking and leads Scotland's transition to a circular economy, receiving funding from both the Scottish Government and the European Regional Fund.

5.4.2 Details of the investigated UK Government Agencies

20. Summary of the firm 20

The twentieth participating government agency is DEFRA. The three persons interviewed from DEFRA were from three different departments and hierarchies. Each person had his/ her understanding of the circular economy. For the Head of the Department (P20), a circular economy is a lifecycle approach for maintaining and maximising the raw material resources productivity by reducing, reusing, recycling, and remanufacturing processes. He feels that the term circular economy is not helpful. Instead, either resource efficiency or resource productivity is straightforward for understanding. He considers the circular economy as a vision and a tool for policymaking. The Statistician (P21) from the materials evidence team understands the circular economy as recycling and zero-to-landfill. He thinks a circular economy is an excellent tool for creating a mindset to reduce waste, and if reducing is inevitable, then recycling is the best way to go. For the statistician, a circular economy has sociological, socio-political and philosophical dimensions. The Economist (P22) believes a circular economy is about raw material resources productivity and the wellbeing of labour, but not resources productivity because the latter involves the labour as a factor of production.

For DEFRA, a circular economy infrastructure is that where (a) there is a strong pipeline of innovation of product and material design, (b) such designs lower environmental impacts and respond to shifting values of materials, (c) reverse logistics infrastructure are in place (d) there is enhanced producers' ability to call back a product that has achieved its end of life, and (e) a network for collaborative consumption.

DEFRA has created a circular economy plan in response to the EU circular economy package, having identified several barriers for its implementation, such as (a) regulatory, (b) financial, (c) informational, and (d) systemic. DEFRA has taken structural measures at the national, regional, and local level to facilitate the transition to a circular economy, and therefore has increased landfill tax and increased its funding to WRAP.

The HOD thinks the accounting principles need reconceptualization in the context of a circular economy.

21. Summary of the firm 21

The twenty-first government agency is The Waste and Resources Action Programme (WRAP) - a delivery partner of DEFRA. It is in the process of implementing circular economy ways of working within different sectors, such as (a) the food and drinks sector (b) clothing and textiles (c) electrical and electronics, and (d) in plastics across all sectors. Two participants, P16 and P17, were from senior and middle management levels.

For the senior manager, the circular economy is about reducing consumption. He aligns his circular economy knowledge with the performance economy of Prof. Stahel, whereas the middle-management participant understands the circular economy as recycling with a new business model and tool meant for policymakers. He links the circular economy to the waste hierarchy, saying people understand the 4Rs, but not a circular economy.

The middle management participant challenged McKinsey and Co.'s projected gains for transitioning to a circular economy. He said McKinsey and Co. have inflated the benefits figures. They arrived at these figures by negating the cost of improving processes and recycling as an active part of the circular economy model, in their Ellen MacArthur report, 'Towards a circular economy – Vol 1, 2, & 3(EMF, 2012, 2013b, 2014). That is, McKinsey & Co. have changed the parameters in the model and reported input of the model as an output. It inflates the final figures, giving a rosy picture of transitioning to a circular economy model. While the reality is the cost of transitioning is absent.

In terms of implementing the circular economy, WRAP has different programmes running concurrently. For example, in the food and drink sector WRAP has 'The Courtauld Commitment 2025.' For the Textiles sector, WRAP has SCAP 2020 (Sustainable Clothing Action Plan). For Plastics, WRAP has 'The UK plastic pact'. WRAP has ESAP 2025, the Electrical and Electronic Equipment Sustainability Action Plan. WRAP is actively working with local authorities to help households across the UK benefit from improved recycling collections, and innovation in reuse, in order to reduce the overall waste generation.

For the senior manager, the notion of profit is maximising revenue. In contrast, the middle manager thinks profit should be in terms of value added to the reserves of natural raw material resources.

22. Summary of the firm 22

The twenty-second government agency is The Environment Agency (EA), which is a non-departmental public body under DEFRA. It is responsible for regulating industry waste; treatment of contaminated land; water quality and resources; fisheries; inland river, estuary and harbour navigations; conservation and ecology; and managing risks of flooding for main rivers, estuaries, reservoirs and the sea.

The interviewee is an adviser in the Waste Regulation department, responsible for waste planning and developing a waste strategy, having both internal and external focus. He has an academic background in Environmental Sciences.

He understands the circular economy as looking at waste flows from the point of production to end-use, assessing what happens in those waste flows, and evaluating their performance. It is essentially about implementing a waste hierarchy. He was unable to present a coherent answer about the EA's understanding of the circular economy. However, he did mention the disruptive model and closed-loop handling of resources as examples of a circular economy.

The EA basically deals with waste regulation and compliance as a national regulator. They formulate waste regulations and manage permits, so all their activities are about reducing waste generation. As a result, they are closer to the circular economy, but the top management does not support the circular economy

The participant seemed to be an environmental activist and critic of government policies. He believes that implementation of the circular economy is not achievable, if the motive is profit-making.

23. Summary of the firm 23

The twenty-third government agency is the Local Partnerships (LPs). They offer commercial and legal expertise to support local and combined authorities with their contracts. Within the waste sector, Local Partnerships help local and combined authorities to manage their infrastructural projects from concept to completion, their services ranging from design to erection to final delivery of an operational project.

The interviewee is a project director, having a background in engineering and an MBA. His responsibilities include helping the Welsh Government to achieve its circular economy ambitions.

He understands the circular economy from a waste management perspective. The participant says a circular economy is beneficial because it helps to find substitutes for scarce virgin materials. According to him, the circular economy is anything that can be recycled beneficially. The circular economy is in a developmental stage and means different things to different people, and is confusing because businesses do not understand how large the circle should be and they are not able to locate their business in the whole gamut of things.

24. Summary of the firm 24

The twenty fourth agency is the London Waste and Recycling Board. It was set up as a statutory board by the Greater London Authority Act 2007. It aims to transform London as the circular economy city of the future and has developed a circular economy route map for London. They are a member of the CE100 club. LWARB has invested about £2 million in 'Circularity Capital', a company jointly owned by ex EMF CEO.

The participant is the circular economy manager, having a background in environmental sciences. She understands the circular economy as making the best use of the available resources by keeping them in their highest value for as long as possible. It is also about creating less waste in the first place. They subscribe to the 'cradle to cradle' concept of Prof. Braungart and McDonough. She says that the EMF educates them about the circular economy, and in turn, LWARB shares it with their members. They have adopted all the activities mentioned in the Accenture business model.

They work closely with the Greater London Authority to reduce waste management and to increase recycling activities. The interviewee was not able to answer the questions on the notion of profit.

25. Summary of the firm 25

The twenty-fifth government department is Innovate UK. It is a non-departmental body funded by aid grants from the UK government. Innovate UK funds businesses and research collaboration to accelerate, de-risk, and support innovation, in order to drive economic growth and productivity, and drive business investments into research and development.

The interviewee is currently Interim Head of Advanced Materials Innovation, but was the Lead for manufacturing and materials at the time of interview. He has a background in Oceanography. His responsibilities are working with business and universities to improve material efficiency through supporting innovative projects. He has a background working for reuse and recycling businesses.

He understands the circular economy as not destroying value and always looking for ways and means to extract more value from a product or raw materials resource. The participant disclosed that the Ellen MacArthur Foundation is hugely under the influence of Prof. Michael Braungart and McDonough’s cradle-to-cradle concept and the EMF has promoted it globally.

The circular economy is used as a branding strategy for reputational gains, and there is cross-over between sustainable business and circular business. Both phrases, i.e. sustainability and circular economy, are being used interchangeably.

In order to promote the circular economy, Innovate UK funds research on reducing the reliance on virgin materials, fossils fuels, and eliminating the use of plastics.

The interviewee strongly believes that in a truly circular economy, the notion of profit does not exist. Instead, profit should reflect the new value created by conserving the reserves of natural raw material resources.

26. Summary of the firm 26

The twenty sixth government agency is devolved Welsh Government established the Department of Natural Resources in April 2013. The department has wide-ranging responsibilities including advisory, regulatory, and strategic, and is acting as a statutory consultee to the Welsh Government on protecting the environment and natural resources.

The interviewee is head of wastes strategy, with a doctorate in Marine Geochemistry. He is responsible for a) developing policies on waste and natural raw material resources efficiency, (b) advising DEFRA in terms of the circular economy package, (c) delivering the waste and resources strategy and monitoring its progress, and (d) implementing the EU waste directives.

The participant says that there are various definitions of the circular economy, such as that of the restorative or regenerative economy, but the Welsh government would like to express it as keeping materials in high-value productive use for as long as possible. They regard the circular economy as a process and not as a result. It is because one can have a circular economy and still use three planets' worth of resources if the economy keeps growing. Therefore, it is essential to reduce the circle, i.e. the use of materials flowing round, and not just keep the circle flowing that eventually grows. He understands circular economy characteristics to be about reducing the actual unit of input of materials per unit of output. Recycling is the most natural form of a circular economy, according to the interviewee.

According to the participant, the principles of a circular economy are (a) design challenge, (b) thinking beyond the life of the product, (c) systems design, i.e. how systems keep the productive value of the product and its materials for long period; and this includes (d) collection systems, i.e. how reverse logistics are designed or operates, (e) supply chain and (f) citizens involvement, i.e. behavioural change.

In order to bring the circular economy into the mainstream, the Welsh government is moving it from the Waste to the Economy department, expressed in the quote below.

'…the economic action plan now for the Welsh Government, the new one requires businesses to meet our policies. So, we are going to try and embed the resource efficiency circular economy side of things a lot more into our economy department' P40

The Welsh Government is not in favour of energy from waste as it destroys valuable resources. Their target is zero incineration by 2030. It utilizes its public procurement powers to secure longer life products, more reuse, more remanufacturing, and more circular economy-orientated business models.

Their ‘Globally Responsible Wales’ programme makes them consider the exploitation of natural resources not only in Wales but also its impacts elsewhere in the world. Keeping this in view, the Welsh Government intends to reduce the size of the circle so that, as a result, it reduces consumption.

The interviewee thinks profit is a contentious issue as it links directly to the funders, and is the basis of the entire governance of the economy. Therefore, he is not qualified to comment on it.

27. Summary of the firm 27

The twenty seventh government is the devolved Scottish Government’s Zero Waste Scotland (ZWS). It was initially WRAP Scotland. The Scottish government wanted to increase investment considerably more in the policy area than the rest of the UK Government. Therefore, the Scottish Government decided to have its own delivery body, so WRAP Scotland became Zero Waste Scotland in June 2014 - an independent company at a time when the circular economy concept promoted by the Ellen MacArthur Foundation was gaining popularity. ZWS is a member of the CE100 club. The funding from the Scottish government and European structural funds runs ZWS.

Two participants from two different departments with different responsibilities participated in this research study. One participant is the head of resources management, whereas the second participant is a circular economy programme manager.

The first participant has a background in waste management, and the second participant has a doctorate in mathematics.

The first participant understands the circular economy as recycling, preventing waste, and extracting the residual productive value from a used product or raw materials resource. The interviewee views the inflating of the benefits of moving to a circular economy by the EMF and McKinsey and Co. as a publicity trick. The participant said the reason for ZWS to become a CE100 club member is to raise awareness about ZWS being on the EMF’s platform.

The second participant understands the circular economy from the perspective of ‘Doughnut economics.’ For her, a circular economy is not only about extracting the maximum residual value from resources, but also renewing the value. In her opinion, this requires reconstructing the social structure and business environment around it, rethinking relationships between businesses and customers and how the society views value. However, the second participant is ignorant about what constitutes a circular economy.

When ZWS engages with businesses to promote the circular economy, they do not talk in terms of saving the planet or saving resources, and they do not even use the circular economy term. However, they project it as about making them more profitable or creating a new product or identifying new markets.

The second participant says that businesses across sectors do not practice the circular economy. However, due to statutory laws and contractual obligations, they do recycle. ZWS works with partners agencies, environment agencies, manufacturers, the resource management sector, the bio-economy sector, to establishes reuse and repair as a social norm.

Both participants agree that businesses do not understand the circular economy, and it needs simplification for more extensive public engagement. The managers that were responsible for promoting/ implementing the circular economy are not clear about it. There is a gap in understanding of those who are promoting it.

The notion of profit of the participants is one of maximising revenues and satisfying the shareholders - this is representative of the notion of profit at the firm level.

28. Summary of firm 28

WRAP participants informed that they deliver the circular economy programmes through local authorities. Therefore, the author got in touch with the Corporate Director of Birmingham City Council, who in turn, directed the author to the head of the business enterprise and innovation team. Thus, Birmingham City Council became the twenty-eight participating local Council under the UK Government.

The interviewee is an MBA having the responsibility to both develop and deliver strategies for ‘the Business Growth Programme,’ including securing funding to run such programmes. The Business Growth Programme offers support across four different strands, which are: The HS2 Supply Chain Programme, The Green Bridge Supply Chain Programme, the Business Innovation Programme, and the Business Development Programme.

The interviewee has never heard about the circular economy term. He says that the business enterprise and innovation team that supports SMEs in the region also do not understand the circular economy.

They understand recycling but are not actively involved in it as it falls within the purview of the waste management department.

The interviewee, along with his team, runs programmes to encourage businesses to move towards greener activity, but nothing related to the circular economy. The waste department works closely with WRAP guidelines issued for local authorities.

The notion of profit the interviewee and his team follows is to maximise revenues and protect shareholders' interests.

29. Summary of the firm 29

The twenty-ninth Government department is the European province of Friesland in the Netherlands. The province is leading the transformation to a circular economy model, funded by the European Commission.

The interviewee is a policy expert on the circular economy within the Economy Department. He participated as a speaker in a SCREEN[45] workshop hosted by Innovate UK as a part of the EUH2020 project. He has a Masters in Economics, and his responsibilities include developing and delivering the circular economy policy for the Friesland region. Additionally, he also acts as a catalyst in bringing interested parties together for establishing the circular economy in Friesland, and lobbies at the national government level to source funding for his region.

He understands the circular economy as a new way of thinking, for changing the current ways of production and consumption. He says the circular economy is not only about recycling or closing the loops, but also about creating new business models, including bio-diversity and people from all walks of life.

He has come up with seven principles of a circular economy, which are (a) using materials that allow high-value recycling for as long as possible, (b) renewable energy addressing all energy requirements, (c) bio-diversity is structurally supported, enhanced and systemically adopted, (d) preservation of human societies and their cultures, (e) supporting structurally and systemically the health and wellbeing of humans and other species, (f) human activities generate values beyond financial measures, and (g) the economic system is inherently capable and resilient.

He argues that the reason for having 114 definitions of the circular economy is that everyone within the European regions is talking about the circular economy, but no one understands what it means. He says that despite committing millions of Euros for promoting the circular economy,

[45] Synergic Circular Economy across European Regions.

the European Commission themselves do not have a clear understanding of it. He says the EU promotion and Friesland's interests in the circular economy are politically motivated. He says, the EU looks at the circular economy more from a recycling, or upcycling perspective, as most EU legislation and their publications are about waste materials. Such a perspective is a restricted vision of a circular economy and attributes to lobbying by the powerful cash-rich companies in the EU. In his opinion, bigger is not growth, and bigger is not better. Instead, small is beautiful. It seems the participant follows Fritz Schumacher (1973).

The Friesland province and the Netherlands practice the circular economy as recycling and view it from a waste management lens. Hence all efforts at governmental levels are to reduce waste generation while handling recovery from waste.

The participants P13, P17, P27 and P40 view wellbeing to be a part of the profit calculations, similar to P28.

30. Summary of the firm 30

The thirtieth government agency is the European Republic of Croatia. The participant is a representative of the Republic of Croatia, where the European Commission is trying to establish a circular economy.

She is a Senior Associate deputed to coordinate between Croatia and the European Union on circular economy matters. She participated in the SCREEN workshop.

The Croatian people are unaware of the circular economy. Those responsible for promoting the circular economy understand it as recycling. They call this the circular economy of waste.

In practice, waste is collected from all around the region, even from schools. Then it is taken to waste management centres for segregation and is used for production. The participant feels that the European Commission does not understand the circular economy and just promotes it by giving away funds.

The uptake of the circular economy is slow among Croatian businesses because they too do not understand it.

The participant views sustainability as narrow thinking and a part of a circular economy.

Table 5-3: Summary of the seven steps for the government agency participants

Summary of the seven steps for the government agencies participants											
Firms (Agencies) The 7 Steps	**Firm 20 - P 20, P21 & P22**	**Firm 21 -P16 & P17**	**Firm 22 - P 27**	**Firm 23- P15**	**Firm 24 – P06**	**Firm 25- P13**	**Firm 26 P 40**	**Firm 27- P36 & P38**	**Firm 28- P24**	**Firm 29 – P28**	**Firm 30 – P29**
About the industry	All government agencies investigated support the circular economy initiative. They develop their legislation and policies for protecting the natural raw materials resources, benefitting the people and economy.										
About the firm	DEFRA is the nodal body responsible for safeguarding the natural environment/ resources and supporting the food and farming industry.	WRAP is the delivery partner of DEFRA.	The Environment Agency is a non-departmental public body under DEFRA.	Local Partnerships offer commercial and legal expertise to support local and combined authorities with their contractual obligations.	The London Waste and Recycling Board is a part of the Greater London Authority. It is a member of the CE100 club.	Innovate UK funds innovative projects to reduce dependency on natural raw material resources.	Department of Natural Resources under the Welsh Government.	Zero Waste Scotland is a member of the CE100 Club.	Birmingham City Council.	Province of Friesland in the Netherlands.	The Republic of Croatia.
About the manager	One is a PhD in Child Psychology, and the second is a Statistician, while the third is an Economist.	The first is a PhD in Chemical Engineering plus MBA. The second is MSc in Integrated Environmental Management.	B-TEC in Environmental Sciences.	Bachelor's in engineering plus an MBA.	Bachelor's in environmental sciences.	Masters in Oceanography.	PhD in Marine Geochemistry.	The first is a waste management expert. The second is a PhD in Mathematics.	MBA.	Masters in Economics.	Masters in Electronics Engineering.
About understanding of the circular economy	Understanding differs with slight variations between three individuals. For one, the CE is about maximising a resource's productivity. The statistician understands the CE as zero-to-landfill. Whereas, for the economist, it is about increasing material productivity without affecting the labour component.	The first understands the CE as reducing consumption in line with the performance economy. Whereas, the second understands it as improving recycling with the help of technology, and considers it as a tool for policymakers.	The CE is about implementing a waste hierarchy.	The CE is about managing waste and finding substitutes for scarce virgin raw material resources.	The participant understands the CE as per the EMF's definition.	The CE is about continually looking for ways and means to extract value from a product or raw materials resource.	The Welsh government understands the CE as keeping materials in high production value for a long time.	One understands the CE as recycling whereas the other as 'Doughnut economics'.	No understanding.	New ways of thinking for changing the current ways of production and consumption.	Recycling is a circular economy.

Table 5-3-1: Summary of the seven steps for the government agency participants

Summary of all Government Agencies interviews										
Firms (Agencies) The 7 Steps	**Firm 20 - P 20, P21 & P22**	**Firm 21 -P16 & P17**	**Firm 22 - P 27**	**Firm 23- P15**	**Firm 24 – P06**	**Firm 25- P13**	**Firm 26 P 40**	**Firm 27- P36 & P38**	**Firm 28- P24**	**Firm 29 – P28**	**Firm 30 – P29**
About practising the circular economy	They have developed a 25-year Environment Plan; Linking Industrial Strategy to the Environmental Plan. Also, DEFRA has developed the Circular Economy Action Plan at the EU level.	WRAP developed The Courtauld Commitment 2025'; SCAP 2020; 'The UK Plastic pact'; ESAP2025 and ReBUS.	The Agency is a regulatory body monitoring the compliance of waste laws.	Local Partnerships do not directly engage in promoting the circular economy.	They developed the London Circular Economy Route map. 3. ERDP offers financial support to SMEs. 4. Improve London's Environment strategy.	They provide funding support to business and research establishments for innovative projects.	They are moving Waste to the Economy department from the Department of Natural Resources.	They created the Institute of Remanufacturing for accelerating the transition to the circular economy. Offer business support to SMEs that have circular business models.	They do not practise the circular economy.	Recycling.is practised as the CE.	Recycling.is practised as the CE.
About handling waste	Waste laws are in place for conserving the natural raw material resources.	They regulate wastes through local authorities.	Develops different legislations from time to time to handle the waste.	Advises local authorities on turnkey waste management projects.	Created recycling Infrastructure to facilitate the hiring of products.	Not involved in waste management.	Manages through statutory laws.	Policy for increasing the amount of household and commercial waste collection.	A waste department manages waste.	Waste management is central to handling waste	Waste management companies manage waste.
About the notion of profit	The first interviewee thinks the accounting principles need reconceptualization in the context of a circular economy. Wellbeing included.	Maximising revenues. Plus value added to the reserves of natural raw material resources.	A truly circular economy is not achievable if profit maximisation is the only motive.	The notion of profit depends upon an organisation’s preference.	The notion of profit is about maximising revenues.	Profit should reflect the value added to the reserves of natural raw material resources.	No views.	Maximise revenues.	They are improving returns on investment.	Profit should include the wellbeing of humans.	No views about profit.

5.4.3 Summary of all interviews within the group of Government Agencies.

Table 5-3 and 5-3-1 above gives a snapshot of all the interviews carried out in the Government sector. The UK and the European Union Governments are aware of the acute shortages of critical natural raw material resources. Aligning with a circular economy is a step towards addressing these shortages. The other reasons for aligning are to address the tremendous fluctuations in resource prices and climate change.

The findings show that the understanding of the circular economy is not uniform, and it differs from one government agency to another. Each participant understands a circular economy according to his/her familiarity with a model or concept. They were inadvertently linking the circular economy to the 4Rs processes. Among the 4Rs, recycling is the most preferred method for diverting waste away from landfill and extending the life of manufactured products and raw material resources. The term ‘circular economy’ is contentious in the Government sector, as the senior managers prefer to use ‘resource productivity’ or ‘resource efficiency’. The political dimension, which is absent from the active circular economy discourse in the automotive and IT sector, emerged as a significant driver in the government sector.

A few participants have conceptualised a circular economy infrastructure where (a) there is a strong pipeline of innovation of product and material design, (b) such designs lower environmental impacts, and respond to fluctuating resources prices, (c) reverse logistics infrastructure is in place (d) there is enhanced producers’ ability to call back a product that has achieved its end of life, and (e) there is a network for collaborative consumption. Thus, a circular economy has sociological, socio-political, and philosophical dimensions.

The current systems of handling waste have several leakages. For example, waste collection is an issue at the Local Authorities level. There are too many agencies involved in industrial and commercial waste collection and waste management. Extended producers’ responsibility is not implemented uniformly across sectors. Litter policy is not uniform and varies across different local authorities - similarly, household waste collection.

There are two views about the circular economy in Zero Waste Scotland. The first view is that the circular economy is about waste management, and making products and materials last longer through recycling and other processes or identifying different ways of using things. A circular economy is resource efficiency topped with energy-saving. The other view is that the circular economy is about maximising value from resources, which stems from the notion of ‘Doughnut economics’. The second group considers a circular economy and Doughnut economics as the same concept. This group considers the wellbeing of employees is paramount, and that growth is the wrong word. They consider leasing and servitization as tools to achieve a circular economy. Recycling is the most prevalent and more straightforward form of a circular economy. The participants at Zero Waste Scotland were not able to articulate the elements of the circular economy.

The Department of Natural Resources in the Welsh Government understands the circular economy as a process to keep material at high production value for as long as possible. In addition to reducing consumption to make the circle smaller, it considers the 'wellbeing of future generations' an integral part of a circular economy. It is the first government to come up with a 'Future Generations Act'. Furthermore, it is considering moving responsibility for the circular economy from the Natural Resources Department to the Economy Department.

The European regions, the Netherlands and Croatia revealed that the European Commission does not understand the circular economy. They say that the European Commission considers that funding would drive the circular economy, but the reality on the ground is that funding alone is not helping the transition to a circular economy. Furthermore, they say the EU has only recycling and upcycling perspectives of a circular economy, which is a constricted view, limiting the potential of a circular economy. In their regions, no one knows about the circular economy, and waste management alone is in practice. So, for them, recycling is a circular economy. They think the importance of the circular economy is hyped and politically motivated.

5.5 Conclusion

The lived experiences of the participants from across the automotive, IT firms and Government agencies have shown that recycling is the common denominator in an understanding of the circular economy. The understanding of the circular economy is not uniform.

The findings show that understanding is context dependent. They also point to several influences and conflicts of interest in practising a circular economy. Waste is managed more as a compliance activity than for reducing environmental impacts. The logic of profit for a majority of participants' firms is to maximise revenues, and/ or buttress shareholders' interests. However, there is growing thinking that supports the inclusion of environmental gains and wellbeing as a part of profit calculations.

In the next chapter, all these findings are triangulated, analysed, and discussed, for answering the research questions.

Part Three

Chapter 6 Analysis and Discussions

6.1 Introduction

This chapter deals with answering the research questions by further analysing and discussing the participants' lived experiences mapped to the seven steps in Chapter five.

The chapter compares and contrasts the detailed individual accounts mapped to the seven steps across the three cases. In other words, intra-case and inter-case comparisons are carried out to produce a rich explanation of the circular economy's understandings and its impact on the firm's use of raw materials resources. It entails comparing the different individual accounts within a case and then conducting comparisons between different individual accounts across the three cases – the automotive, the IT firms and the government agencies.

This exercise helps to identify patterns of events, which, in turn, enables identifying the generative mechanisms and structural influences that give rise to the current understanding of the circular economy. Recognising the structures and generative mechanisms would lead to knowing the reality of the circular economy. The reality of the circular economy would, in turn, help foster a unified understanding of the circular economy across UK manufacturing.

With this view, the author revisited the findings and raw data, after organising the interviews data as per the seven steps detailed in Chapters 3 and 5. The questions that helped in probing the results and raw data for the second time included (a) how individuals claim to understand the circular economy, i.e. what does the participant say when he/she claims that he/she understands the circular economy, (b) what does the participant think of the circular economy as a concept, (c) identifying the words that the participant uses to describe his/ her understanding of the circular economy, (d) what are the other activities carried out under the name of a circular economy, and (e) what is the firm’s motive to follow the circular economy?

The above and a few more questions helped to group the responses into sub-categories as follows:

1. The circular economy understanding is as...,
2. The circular economy is...,
3. The firm practices or operationalises the circular economy as…,
4. Traditional activities rebranded as a circular economy activity
5. Limitations in practising the circular economy…,
6. The seriousness in implementing waste management…,
7. The primary influencer in the understanding of the circular economy…,

8. Views about the UN Sustainability programme, and the Circular Economy…,
9. Is the Circular Economy an evolution or a revolution…?
10. The politics of the circular economy.

In the first round, the researcher mapped each participant responses manually, summarising and tabulating the comparisons within a case (intra-firm comparison) in tables 6-1, 6-1-1; 6-2, 6-2-1,6-2-2; 6-3, 6-3-1, 6-3-2 and 6-3-3 described below. In the second round, the researcher identified themes or patterns from the above tables. A visual sample of the nodes, thus generated in sub-categories, is presented in Appendix 13. It demonstrates the coding process of how the main themes that are shown in figures 6-1 and 6-2 was reached. It also explains how the hierarchical organization of thematic maps 1 and 2 in tables 6-4, 6-4-1 and 6-5, 6-5-1, 6-5-2, and 6-5-3 were reached. A manually coded transcript is presented as evidence of the coding process in Appendix 14.

Apart from grouping and tabulating the responses, the author further grouped other responses that did not map to the seven steps into different sub-categories first manually and then coded them in NVivo using the same sub-categories' names. These sub-categories listed below functioned as sub-themes in NVivo as they helped to tease out the first level codes.

11. Contentious issues
12. Causal mechanisms for the circular economy
13. Components of the circular economy
14. Gatekeeper issues faced by the researcher
15. New information about the circular economy
16. Circular economy in Europe
17. Recommendations from the participants.

A detailed list of all the above sub-themes (having parent and child nodes) with coded files and references in each node are presented as evidence of the coding process in Appendix 15.

This Chapter has seven subsections. Sub-section 6.2 is on analysis of the findings arising from intra-case comparisons. Similarly, sub-section 6.3 analyses the findings arising from inter-case comparisons. Sub-section 6.4 discusses the analyses of the circular economy's understandings and presents a plausible explanation of its current understanding. Sub-section 6.5 discusses the impact of circular economy understanding on the use of firms' resources and capabilities for achieving competitive advantage and marks the emergence of a new competitive advantage. Sub-section 6.7 discusses the policy implications arising out of sub-sections 6.5 and 6.6.

In sub-sections 6.2 and 6.3, the cumulative similarities and differences in responses are presented in per cent terms and illustrated as pie-charts. It is a quantitative style of presentation, adopted for the ease of narration and visual representation. It does not skew the qualitative responses, as the author has used a combination of thematic analysis, and the Critical Realism tools for analysing and developing the most plausible explanation for the understanding of the circular economy. However, this could be identified as a limitation, when the method selected is qualitative cases comparisons, and the results are presented using a quantitative tradition.

6.2 Part 1: Analysis of Findings – Intra-firm Comparisons

Tables 6-1. and 6-1.1 compare different accounts of the participants from automotive firms. Similarly, tables 6-2 and 6-2-1, and 6-2-2 detail the comparisons between different accounts of participants from the IT firms while tables 6-3, 6-3.1, 6-3-2, and 6-3-3 do the same type of comparisons for the Government agencies.

6.2.1 Comparing Automotive firms' participants' responses

Tables 6-1 and 6-1.1 below helps to compare different accounts of participants in the automotive sector to find similarities and differences.

A. ***The comparisons of the descriptions of the circular economy by the automotive firm participants***

Tables 6-1 and 6-1-1 below compare different firms within the inner case nest – Case 1. Each group of firms have a similar understanding of the circular economy. For example, all OEM interviewees understand the circular economy as a recycling plus. Correspondingly all remanufacturing group participants understand the circular economy as remanufacturing. Likewise, responses from the recyclers group understand the circular economy as recycling. The automotive trade association participant views the circular economy from lean management and reducing wastages perspectives. In contrast, the material consultant understands it as a mix of design and reducing raw material resources consumption.

All participants unanimously agreed that the circular economy is not a new concept. Each participant's firm has been practising it either in the name of recycling, or closed looping, or reusing, or sustainability, or green environmental programme, or in some other name. The use of the term 'closed-loop' appeared quite often while participants were describing their understanding of the circular economy.

Table 6-1:Case 1: Comparing the responses of Automotive firms' participants.

Intra-Sectoral- Comparisons of individual accounts.in the automotive firms											
Case 1 Firms **Sub- themes**	**Firm 1-P1**	**Firm 2- P34**	**Firm 3-P42**	**Firm 4-P2**	**Firm 5-P47+48**	**Firm 6 - P32**	**Firm 7 -P5**	**Firm 8- P8**	**Firm 9- P26**	**Firm 10– P30**	**Firm 11- P4**
The participant understands the circular economy as	They understand it as light-weighting the vehicle achieved through the material, product design and closed-loop recycling of raw material.	It is the ability to re-use, recycle and recover materials from conserving resources and reducing environmental impact. Also, to make vehicle lightweight for fuel efficiency.	They understand the circular economy as servitization, i.e. product-as-a-service, furthermore, in terms of achieving zero waste and managing demand to meet supply instead of vice-versa. Product has to stay in the same balance sheet until the end-of-life- resource ownership.	They understand it as recycling and making it closed loop as far as possible. The participant considers the CE an exciting phrase.	It is the manufacturers' responsibility of putting something into the recyclable economy - one which can go back into the marketplace and reuse again.	They understand it as where new products are manufactured using fully recycled material, focused on polypropylene.	Circular economy means either remanufacturing, recycling or reuse. Less wastage.	Finding other use or repurposing a product that has reached its end of life.	They do not understand or are aware of a circular economy. Nevertheless, the waste-heat battery is about storing and recovering heat for later use.	It is about making use of available materials not once but again and again. It is also about designing efficiently recoverable materials.	It is about zero-waste in terms of the value derived from a used or unused material. They advise their client to follow lean management, six sigma and continuous improvement techniques for reducing wastages. They renamed remanufacturing as a circular economy.
The Circular Economy is:	Not a new concept and not clear - a buzzword.	Not a new concept and not clear - a buzzword	No awareness of CE before. CE a buzzword.	Not a new concept and not clear - a buzzword.	Not a new concept and not clear - a buzzword	Not a new concept and not clear - a buzzword.	Not a new concept and not clear - a buzzword.	Not a new concept and not clear - a buzzword	Not clear	Not a new concept and not clear - a buzzword	Not a new concept and not clear - a buzzword
The Circular Economy gets operationalised as:	Primarily close-loop recycling; designing lightweight metal alloys and putting 75% recycled content into a new product.	Reuse, recycle, recovery, life cycle analysis and altering the chemistry of polymers. They are also using it as a brand strategy for promoting environmental awareness.	Technology innovation - alternative to fossil fuel - car runs on hydrogen fuel cell; Market disruptor - changed the business model	The circular part of the business is around recycling.	They are not involved with the circular economy because they are waste handlers; they feed recyclate into the secondary materials market.	Recycling of polymers. The circular economy is about recycling.	Remanufacturing and recycling.	Remanufacturing is carried out since 1969 and considered as the highest form of a circular economy.	They are storing wasted heat energy for later use.	In several ways - primarily as failure analysis and mending the product to be used again.	The CE operationalised as remanufacturing.
Limitations in practising the circular economy	Contamination of aluminium scrap. Not able to get its waste as it gets mixed with other aluminium scrap. As a result, it impacts the quality of recycled aluminium.	The limitation is designing new material that could be easily recycled.	The current structure of the automotive industry is that it awards consumption.	Increasing recycled content is that aluminium production means losing the customer's faith in the quality of the recycled product. Sourcing steady supply of scrap aluminium is an issue. Cartel is another big issue.	Frequent changes in waste regulations.	They practice recycling and consider themselves as the circular economy experts.	Sourcing a steady supply of 'the core'. That is, used electronic component is a big issue.	Practised as recycling, for them too, sourcing a steady supply of used mechanical components is an issue.	Not applicable as they are not aware of the circular economy and have not yet commenced commercial production.	A considerable limitation is reducing the consumption of raw material resources	They do not advise their clients to practice the circular economy - Not applicable.
Activities rebranded as the circular economy banner	Design; altering material chemistry; closed-loop recycling; life-cycle assessment, leasing. Drives a lot of cross-sector and interdepartmental discussions - aligning interests and working together. ReALity car development projected as a circular car project.	Combination of old and new resources; cradle-to-grave concept; life-cycle analysis - understanding flow of materials; branding.	They sell a car as a service rather than a product. The product stays in the balance sheet even after its end of life; all operating cost internalised. All stakeholders' interests aligned for inclusive growth.	Recycle post-consumer cans to make aluminium metal sheets. Aligning with supply-chain for creating a closed-loop network. Aluminium is promoted as CE friendly because it is infinite times recycling capabilities.	Scrap collection, segregation of scrap, bailing and selling into secondary materials market.	Altering the chemical composition of polymers and proprietary processes that enhance the products made up of recycled materials.	Remanufacturing and improving the recycling process. Implementation of ISO14001 and ISO9001. Efforts to be part of manufacturers' supply-chain-adaptation; networking with OEMs. In the lookout for new technology. Extended warranty.	Recycling, reuse, repair, and recovery of materials are activities. Ensure a steady supply of core- supply chain alignment.	The business is yet to commence commercial production.	Failure analysis; materials engineering and selection; welding engineering and corrosion advice - involving recycling and repair	All activities involving waste reduction. Behavioural change initiatives.

Table 6-1- 1: Case 1- Comparing the responses of Automotive firms' participants.

Intra-Sectoral -Comparison of individual accounts in the automotive firms											
Case 1 Firms **Sub- themes**	**Firm 1-P1**	**Firm 2- P34**	**Firm 3-P42**	**Firm 4-P2**	**Firm 5- P47+48**	**Firm 6 - P32**	**Firm 7 -P5**	**Firm 8- P8**	**Firm 9- P26**	**Firm 10 – P30**	**Firm 11- P4**
The seriousness in implementing the waste management	The general waste policy is about recovering scrap aluminium from press shops and post-consumer cans for recycling and reducing environmental impact.	Green Programme, which started as an environmental programme to reduce CO2 emissions and limit natural resource use.	Not yet commenced commercial production but geared towards zero waste.	Global environment management programme that is aimed at reducing solid waste, reducing energy consumption, GHG, water, and zero to landfill.	Handles waste of others as per EU regulations - not applicable.	Waste management policy to save wastages.	Waste management policy focused on reusing materials. ISO 14001 and 16949 certified.	They follows 14001 certifications for controlling wastages in time, water, and materials.	The business is yet to commence commercial production.	Consultancy business therefore not applicable.	Consultancy business hence not applicable.
The primary influencer in an understanding of the circular economy	Ellen MacArthur Foundation; Funded by Innovate UK.	Influenced by Japanese and their partner company is a member of EMF CE100.	A primary influencer is Natural Capitalism by Sir Paul Hawken.	Ellen MacArthur Foundation - a member of CE100. And the innate ability of aluminium to be recycled indefinitely.	None	By the popularity of circular economy, and the opportunity it offers their business, as they are in the recycling business since 2002, much before the circular economy term was coined.	None. However, the need to be a green business is the primary driver for the association with the circular economy.	The popularity of the circular economy hence aligned to it. Driven by lean management techniques, six sigma and continuous improvement is considered as part of a circular economy.	Serial entrepreneurship - success in previous universities spin-out business - follows 'blue ocean' strategy, which is referred to here as 'blue sky.'	By economic and technological developments in the last decade. Primarily by climate change, and prediction of the scarcity of food and water as a result of an increase in global population.	The primary influencer is lean management, six sigma and continuous improvement techniques to improve productivity and reduce costs.
Views about the UN Sustainability programmes and the circular economy	The circular economy is a sub-set of Sustainability. Sustainability linked to environmental initiatives, CE is about circular loops, something specific and focused.	Not able to differentiate between sustainability and circular economy.	Sustainability is a broader church than the circular economy.	Sustainability is broader than a circular economy.	None	Sustainability is comprehensive in its meaning.	No information.	Sustainability is too broad, and for them, often, sustainability relates to the sustainability of the business rather than environment protection or more.	No views expressed.	Sustainability and circular economy are the same.	No views expressed.
Is the Circular Economy is an evolution or a revolution	Evolution of environmental initiatives.	Evolution of Green Programme.	Revolution - radical change.	No difference - circular economy has not impacted what the Co., was doing before.	Not applicable - not practised.	Natural progression.	Evolution - earlier it was remanufacturing now circular economy.	Evolution - since remanufacturing is part of a circular economy.	Not applicable, since they do not understand the circular economy.	Evolution as the consultancy has been advising repairs.	We are renaming alone.
The Politics of the circular economy	The interviewee is promoting himself as a sustainability evangelist, asking the researcher to read the sustainability report because his projects are in the sustainability report. Discouraged the author from meeting other people in the organisation; no response received from the authors of ReAL car project – A circular economy case study. Vested interests' consultancies are making the circular economy.an exciting preposition.	The false claim by the participant that all his team members know about the circular economy when, in reality, they practice recycling.	The real barrier is not technical, rather people, politics, and inertia. No new start-up company with new technology can come up without the support of the big bosses of the automotive industry. The big bosses would not allow it as it would be commercial suicide for them.	a) It is a cartel market b) No one is bothered how they make the metal sheets, whether it is from primary aluminium or coal fire, or high carbon intensity aluminium - for them, it is just a commodity. c) Power play in the supply chain, d) EMF mistreats recyclers and promotes only innovation-centric circular economy.	None reported.	EMF asks for £30,000 to join its CE100 club, and in return, they give access to the elite chain. The participant informed that the EMF encourages people to throw plastics, to throw litter, and then they come up with a solution of Oxo-degradable plastics, which is of little use.	The manufacturers and suppliers stop remanufactured products because they make more money on selling brand new products. All they want is new products and new materials.	They are promoting remanufacturing through SMMT impressing upon the Government to make it mandatory of car manufacturers (OEMs) to use X% of remanufactured component into the new vehicles.	Nil - yet to commence business - not related to the circular economy instead, it is related to blue ocean strategy.	The European Commission does not understand the meaning of circular economy - the political system is wrong for the twenty-first century, and there is a need for a different approach to capitalism, which recognises people as humans rather than units of consumption.	The company publicise themselves as a green business, but there is a cost element behind it to try to reduce driven miles. Furthermore, it is not about CO2 reduction. Moreover, legislation compels companies to do it.

From Tables 6-1 and 6-1-1 above, we find that the waste hierarchy primarily underpins the understanding of a considerable number of participants. It would be not an exaggeration to say that all participants understand the circular economy through the lens of a waste hierarchy. Within the waste hierarchy, the knowledge is primarily about recycling and reducing waste. The participants often refer recycling as closed loop.

All the participants' firms primarily practice the circular economy as recycling and use it for branding themselves as ethical green companies. Most of the participants consider practising recycling as practising the highest form of the circular economy, operationalising it as closed-loop.

Closing the loop involves a variety of activities, both internal as well as external to the firm, and is the source of several causal mechanisms. Externally, these include but are not limited to creating the firm's reverse supply chains, collaborating with third-party recyclers and waste handling companies, and having a network of collaborative operators either regionally, nationally, or globally depending upon how big a loop the firm intends to create. Internally, closing the loop involves altering the physical and chemical properties of raw materials resources, involving either incremental or radical innovation supported by appropriate technology. Technical knowledge about the raw material resources is central to extracting its residual productive services. The technical expertise is also essential for (a) gauging the future demand potential of such raw material resource, and (b) for strategizing to secure a steady supply of such raw material resources. Primarily, the 4Rs, i.e., reduce, reuse, recycle, and remanufacture, in different combinations are being used by the firms. From this perspective, firms 1, 2, 4, 6 and 8 are very much similar.

Firms 3 and 9 are new businesses that do not understand the circular economy but follow reducing the consumption of raw material resources as well as energy, which are central to the circular economy.

All participants' firms work at maximising revenues and creating shareholders' value, and in this respect closing the circuit is in the interest of the firm as it links directly with the logic of profit.

B. Comparing individual accounts for differences in the automotive firms

Using Tables 6-1 and 6-1-1 again, we find that there are variations, even though the majority of participants understand a circular economy as recycling and as a waste hierarchy. The differences are mostly specific to the business needs of a firm. For example, the differences are either in terms of innovative capabilities, and engagement with the 4R processes, or both.

From this perspective, the firm 3 is an excellent example of engaging in radical innovation exhibiting distinctive innovation capabilities not only in terms of technology but also in coming up with a new business model (technology plus new business model). It has the potential to disrupt the current OEMs' market manufacturing passenger cars. The company is making hydrogen fuel-cell cars that would be available to its customers on a subscription basis, moving away from the conventional car ownership model. Effectively, the firm 3 company is selling mileage instead of a product, thereby conserving resources and decoupling economic growth from resources consumption. Firm 3 is different from the firm 1 and firm 2 companies as the latter engage in incremental innovation using 4R processes. The firm 3 does not engage in 4R processes at all.

The firm 9 is in the remanufacturing segment that is a radical innovator, demonstrating high innovative capabilities. It stores waste energy in a battery for use in different applications later. Firm 9 is different as it does not engage directly with 4R processes as the firm 7 and firm 8 do in the remanufacturing segment.

Most of the other firms such as the firm 2, 4, 6, and 8 use 4R processes, either in isolation or in combination for incremental process improvements, often for defending their current market position but rarely for venturing into new markets.

Firms 1, 2, 4, 6 and 8 are companies that close-loop their recycling processes by collaborating with a network of raw material resources suppliers, recyclers and remanufacturers, in order to avoid purchasing used raw materials resources from the open recycling markets, often referred by them as secondary materials market.

The firm 1 and 2 understand the circular economy as (a) light-weighting the vehicle, (b) reducing the dependency of virgin raw materials resources by creating alloys using aluminium, and (c) recovering and reusing the end-of-life vehicles and PET bottles as raw material resources for manufacturing auto components.

Firms 7, 8 and 11 understand the circular economy as remanufacturing, whereas, Firms 2, 5, and 6 as many others understand recycling as a circular economy. Despite knowing about the circular economy, the firm11 does not advise its clients to practice it. Instead, they ask their clients to reduce wastages in manufacturing processes or wherever possible underpinned by lean management, Six-Sigma and continuous improvement management thinking.

Firms 1, 3, 4, 6 and 10 consider the circular economy activities to be inclusive of (a) recycling post-consumer products, (b) leasing, (c) closed-looping, (d) combining and recombining used and virgin resources, and (e) designing new raw materials.

Firms 1, 4, 6,7 and 8 uses the popularity of circular economy to brand themselves as an environmentally and ethically conscious company, whereas other case companies do not use the charm of the circular economy to their advantage.

Some firms 5, 6, 7, 8 take waste management seriously and follow ISO14001 certification or follow the EU regulations. Whereas firms 1, 2, and 4 are less concerned about managing waste because they link waste management either to its environmental policy, or to the Global Environmental Plan that helps them in bringing their wastes back.

The Ellen MacArthur Foundation and McKinsey & Co. define the circular economy, which mainly influences firms 1, 4, 6 and 8. However, the participants P1, P2 and P34 have shared their views about EMF, as follows:

- P1 describes the EMF as having vested interests in promoting the circular economy. He says the way EMF has explained the circular economy no one from the general public would be able to describe what the circular economy means.

- P2 is very annoyed and frustrated by the treatment meted out to his company and similar large multinational recyclers. He says the EMF treats them like poor cousins and just another run-of-mill recycler. He reports that the EMF wants to promote a circular economy that is inclining towards innovation, causing business models which disrupt the current markets. The participant's reporting is accurate as the EMF conducts a heavily-publicised annual event titled 'The Disruptive Innovation Festival.', to promote the circular economy.

- P32 describes the EMF as an ivory tower sort of consultancy, requiring six-figure membership fees to its elite CE100 club. He says the EMF have no experience of recycling or understanding of what is happening in reality.

There are works of other authors that have influenced the participants understanding of the circular economy. For instance, the participant of the Case 3 company understands the circular economy through the works of Sir Paul Hawken, particularly *'Natural Capitalism.'* However, the participant is not able to differentiate between a circular economy and servitization model. Similarly, participant P32 from Case company 2 says that he understands the circular economy, but explains it using the cradle-to-grave concept drawing examples from his Japanese parent company.

There are several reasons for companies to sign up to the circular economy, described by the participants as follows:

- P8 said his company aligned their business due to the sheer popularity of circular economy but viewed it through the lean management lens.
- P5 informed that his company saw an opportunity to supply remanufactured electronic automotive components during the 2007-08 recession and subsequently started branding their business as a circular economy business to ride its popularity curve.
- P30 is concerned about climate change, and, food and water scarcity and, therefore, follows the circular economy, although he does not recommend it to his clients.

Regarding views about UN Sustainability Programmes and the Circular Economy, different participants have various aspects. For example:

- P1, P2, P8, P32, and P34 consider sustainability as a broader church and the circular economy to be a sub-set of Sustainability.
- P1 finds the circular economy to have developed into a multidimensional concept because the circular loops are driving its business models.
- P8 views sustainability to be a broader concept encompassing sustainability of the business as well as the environment.
- P4, P5, P26, P34, and P47 and P48 do not have any view on sustainability versus the circular economy.
- P30 considers sustainability and circular economy to be the same.
- P42 considers the circular economy and servitization to be the same and sustainability to be a broader church.

In terms of antecedents of the circular economy, participants' responses were as follows:

- P1, P5, P8, P30, P32, P34 consider the circular economy to be an evolution of either their environmental initiatives, green programme, or the waste hierarchy.

- P2 and P4 see no difference between recycling and the circular economy and say the circular economy is just renaming recycling.

The participants reported their firm's limitations in implementing recycling - the most prominent approach to understanding a circular economy. The barriers varied from company to company. For instance, car manufacturers face challenges in dealing with their supply-chains, particularly in getting back their waste uncontaminated as they strive to maintain or improve the quality of products manufactured using recycled raw material resources.

Cleaning of the used electronic and automotive components (usually referred to as 'the core') is a significant issue faced by remanufacturers. Also, sourcing a steady supply of 'the core' is a significant problem. To ensure regular and stable supplies of 'the core' the small and medium recyclers and remanufacturers vie to be on the approved vendors' list of the OEMs. These SMEs face considerable challenges to break into the elite circle of approved vendors. Therefore, the SMEs adopt all sorts of methods to be on the approved list, and one of the ways to be on the list is to become a member of the CE100 club, which assures them of being a part of the networking groups of FTSE 100 companies. The other methods include lowering the profit margins, aligning their business processes to that of the large OEMs, or agreeing to the demands of large OEMs made at the time of issuing a purchase order or signing a contract for a particular job.

The recyclers of metals, as well as non-ferrous metals, face challenges particularly relating to complying to the frequent changes or unclear waste legislation. Waste collection and segregation pieces of machinery and infrastructures require substantial capital investments and frequent changes in waste laws make their investments redundant. As a result, recyclers look for ways and means to by-pass the legislation, often cutting corners and making compliance a 'tick the boxes' activity. Both types of recyclers differ considerably in complying to both national and EU waste legislation. Among the several ways that recyclers adapt, a couple includes either branding themselves as a circular economy compliant company or becoming a member of the elite CE100 club.

These causal mechanisms take the circular economy away from its goals, leading to its politicisation, which adopts different forms and in varying depths. Some of them are as follows:

- Vested interests are promoting the circular economy to enhance their business's credibility as a green company or branding itself as an ethical company. Whereas, in practice, they may be manufacturing products using virgin raw material resources by consuming high non-renewable energy. Alternatively, buying a membership of the CE100 club to secure or expand the business.

- Buttressing a cartel market: The existence of a cartel signifies that the power is in few hands as they regulate both the primary and secondary raw materials market.

6.2.2 Comparing IT firms participants' responses

The Tables 6-2, 6-2.1, and 6-2.2 below helps to compare the accounts of participants to find similarities and differences.

A. Comparing individual accounts for similarities in the IT sector

Participants from firms 12, 13, 14, 15, and 19 understand the circular economy almost in a similar manner. That is, they see it as a tool for decoupling revenue growth from resources uses, by keeping the raw material resources in productive use for as long as possible.

The EMF and McKinsey & Co.'s definition is the primary influencer on such an understanding of the circular economy as it calls for replacing the end-of-life concept through the elimination of waste, encouraging reuse, recycling, and recovering activities. In quantitative terms, five participants out of eight, means more than fifty per cent align with the EMF and McKinsey & Co.'s definition. Furthermore, firms 12, 13, and 14 are members of the CE100 club. Out of these three firms, two firms are in the list of FTSE 100 companies while the third is an FTSE500 company, which points towards the causal mechanisms of influencing the circular economy narrative.

The participants from firms 12 (P11), 13 (P49), 14 (P14), 16 (P3), and 19 (P9) report that their firms practice recycling, and it is central to their understanding of a circular economy.

All participants view the circular economy as a subset of the UN Sustainability Programme, except participant 49, who considers sustainability to be a subset of the circular economy.

All participants consider the circular economy to be an evolution of either the environmental programme or greening operations, except participants P3 and P33 - they regard it as a revolution backed by technological advancements.

The participants P3, P9, P11, and P49 unanimously agree that the circular economy is not a new concept.

The participants (P11, P14, P18, P33, P45 and P49) belonging to firms 12,13, 14,15,17, and 18 respectively, report that their firm manages waste as a part of their environmental policy.

Table 6-2: Case 2: Comparing the responses of the IT firms' participants

Intra-firm Comparisons of individual accounts in the IT sector								
Case 2 Firms **Sub- themes**	**Firm 12- P11**	**Firm 13-P49**	**Firm 14- P14**	**Firm 15- P18**	**Firm 16- P3**	**Firm 17 –P33**	**Firm 18- P45**	**Firm 19- P9**
The participant understands the circular economy as:	It is about decoupling revenue growth from the consumption of raw materials resources, energy and other resources. It consists of recycling and repairability.	It is about keeping value in materials for as long as possible. The CE is a new term encompassing many traditional things such as sustainable material usage, recycling, and a new addition is the new business models- So it looks at things more holistically.	For him, the CE is regenerative. It means using renewable materials and energy for manufacturing products. Also, using partial manufacturing, which means using components from used equipment.	It is recycling on steroids, and about the re-engineering of products from conception to its end of life.	It is Zero-to-landfill and recycling and reuse.	There is no clear understanding of the circular economy, whether it is moral based or economics based. The participants understand the digital economy but not a circular economy.	No understanding of the circular economy - relates it to design thinking and design perspective of product development. A circular economy is about cradle to grave and beyond.	Keeping materials, components and products in productive use for as long as possible through reuse, and recycling and reducing environmental impact.
The Circular Economy is:	It is not a new concept. Earlier, it was known as environmental programmed during the1980s.	It is not a new concept. However, it is a new flag that aligns everybody under it.	Not a mainstream term.	Emerging, immature and little understood. Furthermore, an old concept manifested in the use of solar panels ad not wasting water.	An old concept. Comet Circle ^{TM}, associated with the circular economy, is essentially recycling.	Feasible with digitalisation and linked to six sigma and lean manufacturing that eliminates wastages.	Design thinking, moving beyond making money.	A new term for repair, reuse, recycling, remanufacturing, leasing, and extended warranties etc.
The Circular Economy gets operationalised as:	The firm operationalises it as recycling, re-use, repair and an ink-as-service business model. They also use post-consumer plastics to manufacture ink cartridges and printer components. The circular economy helps them in their corporate branding.	Reduce, recycling, recover, reuse with particular emphasis on recovery using global close looping.	Reducing waste and extracting components from used equipment or redistributing the end of life equipment in other markets and recycling, and recovering materials from PCBs, and repurposed plastics.	Re-use and redistributing the old instruments that have reached their end of life. Use alternative power sources, continuous improvement. They are recycling paper and water.	They do not practice the circular economy. However, they use additive manufacturing that conserves resources and reduces time to market.	Simulating factory processes, digitalisation of manufacturing processes for flexible manufacturing and improving resource productivity. Includes Industry 4.0 Artificial Intelligence, robotics, machine learning, productive maintenance. Additive manufacturing.	They do not practise a circular economy - it is design thinking that takes precedence, and they use life cycle analysis before designing a product.	Reuse, refurbish, repair, recycle, remanufacture, recover, and disposal of waste as per WEEE and EU regulations.
Limitations in practising the circular economy:	Aligning all business processes for an MNC around the circular economy is very difficult. Furthermore, accounting practices, both internal and external, including financial reporting, do not support activities involved in a circular economy.	The shredded materials that recyclers offer for remanufacturing do not meet ISO certified specifications. At the remanufacturers end, it is a big challenge to get rid of impurities in used materials.	The understanding of the circular economy principles to project managers and designers. Difficulty in designing telecom instruments with recycled content.	The senior management buy-in is key to the success of the circular economy, including creating reverse logistics chain.	Most of the raw materials for 3D printing / manufacturing are not recyclable. For example, PA11 & PA12 are not fully recyclable and combining with virgin material for reuse is not possible, whereas polypropylenes are 90% recyclable.	The limitations are the tariffs imposed on the return of used goods as well as on raw materials.	The client's mental makeup about the possibility of digitalising their factory processes is critical.	There is an aversion by businesses to change - designing for durability, Closedloop manufacturing, creating a reverse logistics chain, getting secured supply of the core. The huge restriction is unclear waste directive and WEEE regulations.

Table 6-2- 1: Case 2: Comparing responses of the IT firms' participants

Intra-firm Comparisons of individual accounts in the IT sector								
Case 2 Firms Sub- themes	**Firm 12- P11**	**Firm 13-P49**	**Firm 14- P14**	**Firm 15- P18**	**Firm 16- P3**	**Firm 17 –P33**	**Firm 18- P45**	**Firm 19- P9**
Activities rebranded as the circular economy banner	(a)Dematerialisation (b) Design for recyclability (c)Built-in energy efficiency (d)Innovation in materials/metallurgical chemistry.	They used Cloud Storage Technology or Cloud-as-Service that allows Sharing Platforms, thereby helping to optimise the processes and reduce the consumption of raw materials resources.	Use of renewable energy, lowering CO2 emissions in its fleet and buildings, recycling and redistribution of equipment.	The circular economy is widely popular across the organisation - however,10% of revenues allocated for academic R & D of materials and new materials.	3D printing or additive manufacturing, material design through chemical restructuring (a combination of used plus virgin resources) of polymers. Recyclate back to the factory through supply- chain.	They are closing the loop through digitalisation, i.e. known as 'one source of truth'.	They do not carry any activity under the circular economy banner.	Digital and digitised manufacturing processes to improve resource efficiency - Smart factories, Automation, IIOT, Robotics, 3D manufacturing, Artificial Intelligence, Block-chain to track materials.
The seriousness in implementing waste management:	Waste management is part of the global environmental policy and under corporate social responsibility. The activities include collecting PET bottles from developing countries employing economically challenged individuals. It offers the company the opportunity to ensure a steady supply of PET bottles for manufacturing ink and printer cartridges while branding itself as a socially responsible corporation.	Waste management was earlier called 'Reuse hierarchy. Nothing has changed except it is now referred to as 'we follow circular economy principles. Currently, supply-chain comes under waste management as it brings back the recovered gold from PCBs.	Waste managed under environmental policy, and it aims to divert waste from landfill.	Waste managed under environmental production, plans- efficiently, recycles its water, lowers GHG emission, reducing electronic- waste through the scarp management system.- all of these done from a Compliance perspective.	No information obtained.	Waste management is under environmental policy indicates it is only a compliance activity.	Environmental policy. They are committed to achieving UN Sustainable Development Goals, and their target is to use 100% renewable energy for their flagship Cloud Computing Services	Not applicable.
The primary influencer in an understanding of the circular economy:	The leading influencer for P11 is Prof. Walter Stahel's performance economy. The EMF also influences P11 because the corporation is a member of the CE100 club.	Accenture and the EMF. They are a member of the CE100 club.	EMF - a member of CE100, Environmentalism.	They learnt about the CE from EMF and Mckinsey and Co. report.	Not too keen on the circular economy. No influence observed.	Technological development.	Do not understand the circular economy hence no influence. However, P45 links the CE to design.	None

Table 6-2- 2: Case 2: Comparing responses of the IT firms' participants

Intra-firm Comparisons of individual accounts in the IT firms' participants								
Case 2 Firms Sub-themes	**Firm 12- P11**	**Firm 13-P49**	**Firm 14- P14**	**Firm 15- P18**	**Firm 16- P3**	**Firm 17 –P33**	**Firm 18- P45**	**Firm 19- P9**
Views about the UN Sustainability programmes and the circular economy:	The circular economy is more economics orientated as compared to the UN.	Sustainability is a subset of the Circular Economy.	Sustainability is more comprehensive and encompassing, while the circular economy is more about an economy that is renewable and falls under environmental sustainability.	Sustainability is a collection of series of activities of which circular economy is one, i.e. the circular economy is a subset of sustainability.	Sustainability is known, but a circular economy is not.	No views - digitalisation is an enabler of sustainability.	The circular economy is broader than sustainability, which speaks more about carbon footprint and recycling. Sustainability is a sub-set of a circular economy.	Sustainability is all-inclusive as opposed to the circular economy or resource efficiency or resource productivity.
The Circular Economy is an evolution or a revolution:	It is an evolution of their environmental programmes.	Evolution	Evolution, seen as a part of environmental sustainability.	Evolution	3D is an enabler of the circular economy. It is a new technology. Therefore, the CE is a revolution. However, for P3 the CE does not matter.	Revolution brought about by digital transformation.	Evolution	For the tech sector, it is both - evolution and revolution.
The Politics in the circular economy:	There is a dichotomy. The firm's carbon footprint is similar to that of the Airlines industry. They are not particularly interested in lowering their carbon footprint but keen on having an exciting story to oblige their largest customer, Philips, because it wants a compelling story from them. Furthermore, Philips is a founding member of the EMF and the reason for this case company to become a member of the CE100 club. This arrangement is external closed looping.	It is using the circular economy to bolster its agenda of maximising revenues.	None reported.	They get interested in a circular economy because of the gatekeeper also their biggest customer - did not want to displease them. A circular economy is not something that they discuss.	The race is to acquire polymers (resources) that the competitors do not have for competitive advantage. Competition is for developing proprietary processes/polymers.	Vested interest by EMF to include digitalisation and digitalisation as part of a circular economy. While in fact, digitalisation/ digitisation and circular economy are distinctively difficult.	None reported	There is a massive influence of the waste management sector in making the circular economy waste centric, which is the result of lobbying by the top executives' of the waste industry in the Parliament. The EMF has also created the CE100 club that lobbies globally to promote the circular economy.

B. Comparing individual accounts for differences in the IT sector

From Tables 6-2, 6-2-1, and 6-2-2, we find that some participants understanding is not under the influence of the EMF and McKinsey & Co.'s definition. These participants are unaware of the circular economy, but take a calculated guess linking the circular economy to zero to landfill, recycling, and reuse. For instance:

- The firm 16 is an additive manufacturer, and its participant P3 does not know about the circular economy. However, he says that he understands the circular economy as zero-to-landfill, recycling and reuse, and the central role of technology in facilitating all such processes.
- Similarly, the firm 17 is an MNC providing digital automation solutions, and its participant P33 also does not know about the circular economy. Nevertheless, putting digitalisation and process automation in the centre, he links it to recycling.
- The participant P45, from the software development firm 18, did not know about the circular economy but views it from a design and re-engineering perspective. Whereas the participant P18 links it to product management. In both aspects, the availability of raw materials, product features, and the state of raw materials at the end of a product's life is weighed right at the start of designing the product.
- Similarly, reuse is central to P14 and P18's understanding of the circular economy.
- The participant P49 (firm 13) informs that for them the circular economy revolves around recovering gold and close-looping any scarce raw materials resources that the company uses for manufacturing its products.
- The participant P11 considers Prof. Stahel's performance economy to be a part of the circular economy.

The above similarities and difference are consistent with the circular economy literature from the perspective of its understanding. However, such an understanding cannot be definitive because an understanding could be under some influence. It shows the need to find the mechanisms and structures that may be causing such an understanding to be empirically noticeable.

From this perspective, this study finds that firms practice a circular economy, as relevant to their business. Different firms implement it as follows:

- The firm 12 (P11) reuses and recycles its printers and ink cartridges and provides ink-as-service.

- The firm 13 (P49) engages heavily in reducing its dependence on virgin raw material resources through recycling and recovery. They have also carried out the virtualisation of their services using iCloud powered by renewable energy.

- The firm 14 (P14) repurposes its telecommunication equipment, often recovering components from the end-of-life equipment for use in other applications. Also, firm 14 uses renewable energy to power its Cloud Services for lowering CO_2 emissions.

- The firm 15 (P18) follows P14 but does it from a product management perspective while the firm 14 does it as an environmentally responsible company.

- The firm 16 (P3) does smart designing of material through a combination of used and virgin raw material resources using 3D additive manufacturing, thereby saving raw materials, reducing cost and time.

- The firm 17 (P33) recommends digitalising factories first and then, simulating factory processes before going into production. Digitalisation and simulation offer flexibility to change designs without physically consuming raw material resources while saving time, cost and energy.

- The firm 18 (P45) conducts a lifecycle analysis from a design point of view and not from a Cradle-to-Cradle™ perspective. They also do flexible and hybrid manufacturing.

Only P49 considers sustainability to be a subset of the circular economy. At the same time, most of the other participants view UN Sustainability to be more comprehensive, being made of a collection or series of activities.

A circular economy is revolutionary for P3, P33 and P45 due to the influence of technology, which helps to unlock immense possibilities.

The politics in the circular economy is to make it waste-centric due to lobbying by the waste management industry's top executives in Parliament. Therefore, we find that recycling targets are always in weights, which is also one reason for the low interest in plastics recycling.

Another politics of the circular economy is to promote closed-looping. It is primarily to advance a firm's interests to control the ownership of scarce raw material resources under the guise of 'collaborating for protecting the environment.' For example, computer manufacturers' carbon footprint is above 2%, similar to the Airlines industry, but no one is concerned about it. One of the computer manufacturer's top clients is 'Philips' (it is also the leading funder of the EMF for promoting the circular economy and a co-founder of the CE100 club).

Being the biggest consumer of computer products and accessories means the carbon footprint of Philips is also high. Philips collaborates with the computer manufacturers and asks them to lease their computer products and accessories to them. This leasing model allows computer products and accessories to go back to the computer manufacturer at the end of their productive life. It is a circular economy for Philips and the computer manufacturer and similar collaborators. In reality, Philips's carbon footprints have not come down because it continues to consume the same or maybe more computer products and accessories, not directly but through a leasing model. In other words, Philips dictates the circular economy story that the computer manufacturer tells the world.

The logic of profit followed by P3, P33, P45 includes people, i.e., humans' wellbeing and generational equity. While P9 and P14 agree that 'value' that is created needs to be captured, i.e., there should be a paradigm shift in the way raw material resources are handled, while they are in stock as inventory, when in use, and after use. Also, profit should account for the value-added in each step of the production process. Participant P18 highlights the need to change accounting principles, assigning terminal value to those products and raw materials that are not of any further productive use. P11 and P49 follow the logic of maximising revenues.

6.2.3 Comparing Government agencies participants' responses

The Tables 6-3, 6-3-1, 6-3-2, and 6-3-3 below compare individual accounts recorded from different governmental agencies for identifying similarities and differences presented in the following paragraphs.

A. Comparing individual accounts for similarities

It is evident from the below tables that all participants understand the circular economy from the waste hierarchy perspective, albeit there are slight variations. For instance, the participants, P15, P21, P27, P29 and P36, understand a circular economy similar to implementing the waste hierarchy. Whereas the participants P6, P13, P38 and P40 view the circular economy in terms of value achieved by (a) keeping materials in their highest productive use for as long as possible, (b) maximising profit from a resource by extracting the residual productive capacity as many times as possible, and (c) breaking down the products that have reached their end of life into technical and biological nutrients, deriving benefits by putting each nutrient back into use in different applications.

The participants P16, P17 and P20 understand the circular economy a bit differently. These participants understand the circular economy as reducing the consumption of raw material resources and designing things creatively that allows for reducing, reusing, recycling, remanufacturing and recovery processes supported by new business models. They also consider a circular economy to be only recycling, plus a new business model linking it to the waste hierarchy. Additionally, they also view it as a life-cycle approach composed of a waste hierarchy and innovation to increase a product's life and conserve energy.

Participant P15 understands a circular economy as one that helps in finding substitutes for scarce virgin resources.

For P22 and P28, the circular economy is about maximising material productivity across the spectrum of production processes but excluding labour productivity and new thinking that involves recycling and biodiversity, encompassing all society's strata.

P24 was not aware of the circular economy.

These different understandings expand the circular economy canvas, as participants see it as a process, a strategic framework, an economic activity and a social movement.

Table 6-3: Case 3: Comparing the responses of the Government agencies participants'

Comparing individual accounts in different government agencies														
Firms (the Agencies)	**Firm (the Agency) 20**			**Firm 21**		**Firm 22**	**Firm 23**	**Firm 24**	**Firm 25**	**Firm 26**	**Firm 27**	**Firm 28**	**Firm 29**	**Firm 30**	**Firm 31**
Sub-themes	**P20**	**P21**	**P22**	**P16**	**P17**	**P27**	**P15**	**P6**	**P13**	**P40**	**P36**	**P38**	**P24**	**P28**	**P29**
The participant understands the circular economy as:	A life-–cycle approach to maintaining the value, and maximising resources productivity of material resources and products that are in the economy. It is a waste hierarchy with innovation to increase the life of products and conserve energy.	Making the most of the resources. i.e. more recycling, zero waste to landfill and incineration, avoiding residual waste, Achieving resource efficiency.	To Maximise material productivity across the production process spectrum without affecting other factors of production, particularly labour.	Reducing the consumption of materials and resources. A way to design things to last longer through different business models to keep them in play also involving recycling, reuse, repair, remanufacture, recover.	Recycling plus new business models. Linked to waste hierarchy.	Implementing waste hierarchy is following the circular economy.	It understands from a waste management perspective. The basis of the circular economy is anything that can be recycled beneficially, i.e. not burnt. Not benefitting from incineration where through heat energy is generated but value from materials is permanently lost.	Keeping materials in the highest value and in use for as long as possible. It is recycling plus.	Goes by EMF definition, i.e. regenerative and restorative products broken down into technical and biological nutrients and looking for ways and means to extract value multiple times through repair, recycling and remanufacturing.	It is a process and not a result for keeping materials in high-value productive use for as long as possible.	Embedded in the waste hierarchy where recycling waste prevention are central pillars. Thinking of not only designing products differently but also thinking of second and third life of the materials.	Making the best use of resource and maximising value from that resource.	Not aware of the circular economy but knows what is recycling.	It is new thinking that impacts many things. It is recycling plus biodiversity and involving people from all the strata of society.	3Rs- Reuse, recycle and recover.
The Circular Economy is:	A complex concept and the term not helpful at all. Better words and the widely understood name are resource productivity.	It means different things to different people. The term is quite loose and vague.	To minimise the residual waste. For some, it has a sociological, socio-political, and philosophical dimension. It means different things to different people.	Innovation plus new business models that delivers high value and service to customers. More about effectiveness rather than efficiency	Nebulous, because the circular economy is not one thing. It is an old concept.	Looking at wastes flows from production to end-use and finding out the performance at each stage.	It is in the development stage. Means so many different things, helps find a substitute for scarce virgin resources, new emerging market-because current linear movement of raw materials into new products. It is about moving up the waste.	Difficult to understand and requires someone to make it relevant for business.	It is an old concept. Not a helpful term.	Relatively new thinking for longevity reuse, remanufacture and recycling side of things and having in mind the impact on the larger picture.	It is achieving resource efficiency topped up with energy-saving water-saving, electricity-saving, heat saving, and tracking material through to its origin.	Not much practised. It means different to different people because there is no theoretical framework.	Not applicable.	It is hyped and politically motivated. It is confusing 114 definitions of the circular economy. Everyone trying to understand what it is.	Recycle, reuse and recharge

Table 6-3- 1: Case 3: Comparing responses of the participants from different government agencies

Comparing individual accounts in different government agencies															
Firms (the Agencies)	**Case 20**			**Case 21**		**Case 22**	**Case 23**	**Case 24**	**Case 25**	**Case 26**	**Case 27**	**Case 28**	**Case 29**	**Case 30**	**Case 31**
Sub-themes	**P20**	**P21**	**P22**	**P16**	**P17**	**P27**	**P15**	**P6**	**P13**	**P40**	**P36**	**P38**	**P24**	**P28**	**P29**
The Circular Economy gets operationalised as:	A vision about where to get to, and a concept for policymakers. Substituting primary virgin resources.	Changing behaviour norm to shared ownership of assets or leasing model. It is something people can aspire to for an ideal form for organising.	Improving material productivity.	It is an opportunity to make more money with fewer resources.	A policy instrument for policymakers and business trying to persuade customers to access goods in different ways.	Implementation of the waste hierarchy.	They are not promoting circular economy or advising any authorities on it.	New markets, greater efficiencies, resource savings. Way to have a competitive edge.	It is a combination of technology and business models. Do more with less.	Economic activity that offers alternative ways to think about social welfare (well-being) more holistic while addressing environmental issues.	A concept where serious money is involved creates profitability, increase turnover, increase the number of jobs.	Servitization and leasing model.	It relates to waste management.	It is recycling and upcycling.	Waste management, primarily recycling.
Activities rebranded as the circular economy banner	Activities around waste hierarchy-– reduce, reuse, recycle, remanufacture, innovation, reverse, logistics, collaborative, consumption	Resource productivity, creating less waste in the first place.	Resource productivity through recycling, repair, reuse, remanufacture without making it labour intense.	Design, reuse, recycle, remanufacture, extended producers' responsibility.	Repair, reuse, recycle, remanufacture, Leasing, model, and Extended producers' responsibility.	Waste auditing, assessing performance in handling wastes, compliance and regulatory enforcement.	No activities identified because they are not promoting the circular economy.	Remanufacturing, rent tools and apparels, green procurement, green products, service instead of buying, product, reusable buildings, collaboration, increase recycling activities, innovation designing our waste, design for adaptability, disassembly.	It is an innovation incremental or radical both in terms of technology and business models.	Eco-design, more recycling, more reuse, recover, protection of natural resources.	Closing the loops or shortening the circle.	They are increasing efficiency and profitability.	Green-bridge supply chain programme, not related to the circular economy.	Waste management and recycling.	None.

Table 6-3- 2: Case 3: Comparing responses of the participants from different government agencies

Comparing individual accounts in different government agencies															
Firms (the Agencies)	**Firm 20**			**Firm 21**		**Firm 22**	**Firm 23**	**Firm 24**	**Firm 25**	**Firm 26**	**Firm 27**	**Firm 28**	**Firm 29**	**Firm 30**	**Firm 31**
Sub- themes	**P20**	**P21**	**P22**	**P16**	**P17**	**P27**	**P15**	**P6**	**P13**	**P40**	**P36**	**P38**	**P24**	**P28**	**P29**
The primary influencer in an understanding of the circular economy	The ruling Govt. perspective to waste hierarchy and its 25-year environmental plan.	The ruling Government perspective to waste hierarchy and its 25-year environmental plan.	The ruling Government perspective to waste hierarchy and its 25-year environmental plan.	Performance economy by Prof Walter Stahel.	Performance economy by Prof. Walter Stahel.	A blend of information that is available in the public domain around the circular economy.	No information.	EMF, member of CE 100 and cradle to cradle concept. Accenture circular business model.	EMF hugely influenced by cradle to cradle concept.	EMF, but devised their understanding of the circular economy out of it.	EMF, member of CE100 (the reason for the membership is to raise awareness about its organisation).	Doughnut economics by Kate Howarth.	Nor applicable.	Economic reasons. , EMF for definitions.	
Views about the UN Sustainability programmes and the circular economy	Sustainability has different dimensions, and the circular economy is one dimension of it.	Sustainability is wider than the circular economy	The participant did not disclose.	Sustainability has a whole range of dimensions as it has three pillars - environmental, economic and social. While the circular economy helps part of sustainability the circular economy is a subset of sustainability	The circular economy is an enabler of sustainability	Sustainability is overarching, and within it is the circular economy.	Sustainability is more from an environmental perspective, while the circular economy is from economic benefits.	The participant did not disclose.	Not too sure to articulate the distinction between sustainability and the circular economy.	The circular economy is one dimension of UN Sustainability.	Sustainability is context - dependent, while the circular economy is a zero waste thing which has its application in every sector.	No information.	Understands resource efficiency and sustainability .	Sustainability and circular economy are the same. It depends upon the EU how they would want to market the term.	Sustainability is part of the circular economy. UN sustainability goals are pretty narrow.

Table 6-3- 3: Case 3: Comparing responses of the participants from different government agencies

Comparing individual accounts in different government agencies															
Firms (the Agencies)	**Firm 20**			**Firm 21**		**Firm 22**	**Firm 23**	**Firm 24**	**Firm 25**	**Firm 26**	**Firm 27**	**Firm 28**	**Firm 29**	**Firm 30**	**Firm 31**
Sub- themes	**P20**	**P21**	**P22**	**P16**	**P17**	**P27**	**P15**	**P6**	**P13**	**P40**	**P36**	**P38**	**P24**	**P28**	**P29**
The Circular Economy is an evolution or a revolution	Evolution	Evolution	Evolution	Evolution	Evolution	Evolution	Evolution, moving up the waste hierarchy.	Evolution	Both an evolution and revolution.	Evolution	Evolution	Evolution	Not appliable.	None. Change of name.	Evolution
The Politics in the circular economy	Promoting the term resource productivity in place of the circular economy. Resource productivity Is conservatives preferred term.	Dichotomy - promoting the term resource productivity in the place of the circular economy and talking of austerity budget cuts	Dichotomy - promoting the term resource productivity in the place of the circular economy and talking of leaving labour untouched, while denouncing austerity.	Shifting focus, remanufacturing is the essence of the circular economy as opposed to recycling.	The doctoring of data to promote the circular economy is a lucrative business proposition involving colossal monies.	The participant did not disclose.	The poor success of the circular economy is due to the wrong priority of local politicians to join up with what the waste industry wants, and there is a gap between national-level priorities and local level implementation, which is up to the local politicians.	The members of the CE100 club are FTSE 100 companies, having links within the government. These members lobby to promote that circular economy as a panacea for enhancing national growth, more so, in the light of the Brexit crisis.	Dichotomy - local government funds the waste industry, waste industry lobbies government to make it central to the circular economy or any environmental initiative.	Ministers are not comfortable with the term circular economy; hence they use resource productivity. Five-year electorate cycle is an issue.	ZWS is promoting the circular economy as a concept where serious money is involved.	They do not use the words circular economy as a concept where serious money is involved.	The Corporate Director - Economy, directed the researcher to speak to the P24. However, the researcher for that, the P24, was utterly ignorant about the circular economy.	EU does not know anything about the circular economy. Politicians promote the circular economy by providing money because many people do not see the worth of the EU after Brexit. Fake news about the circular economy	The participant remarked that the EU thinks by giving money, the circular economy will be established.

B. Comparing individual accounts for differences in Case 3

- The circular economy is not a helpful term (P13, P20).
- The circular economy is hyped and politically motivated (P28).
- The circular economy has sociological, socio-political and philosophical dimensions (P22).
- The circular economy is an old and complex concept (P13, P17, P20).
- The circular economy means different things to different people and is confusing (P15, P17, P21, P28, P38).
- The circular economy is in the development stage, is nebulous, and is relatively new thinking (P15, P17, P40).
- The circular economy requires someone to make it relevant for business (P6, P38, P40).

The terms 'resource productivity' and 'resource efficiency' are used instead of the circular economy by P20, P21, and P22. These three participants, including P36, P38, and P40, believe that it is easy to understand resource productivity or resource efficiency instead of the circular economy term.

The Circular Economy is promoted as (a) a concept where serious money is involved, which creates profitability, increases turnover, and decreases unemployment (P36); (b) new markets, greater efficiencies, and an opportunity to make more money with fewer resources (P6, P13, P16, P22, P38), and (c) a policy instrument for policymakers, and a vision (P17, P20, P21, P38), and (d) changing the behavioural norm for collaborative consumption, and addressing the well-being of people in a holistic manner (P21, P22 P40), and (e) improving material productivity, implementing the waste hierarchy, recycling and upcycling, waste management, and servitization (P22, P24, P28, P29, P38).

Other activities branded as a circular economy activity are (a) green procurement and green products, (b) collaboration, (c) buying services instead of the products, (d) incremental and radical innovation (in terms of both technology and business models), (e) designing out waste, (f) design for adaptability, (g) design for disassembly, (h) extended producers' responsibility (again, an old concept), (i) reverse logistics or reverse supply chain, (j) greening the supply chain, and (h) eco-design.

From tables 6-3, 6-3.1, 6-3-2, and 6-3-3 the understanding of the circular economy from P6, P13, P28, P36, P38, and P40 is primarily under the influence of the EMF. However, P40 has chosen to focus only on keeping materials in high-value productive use. The other participants, P16, P17, are influenced by the performance economy concept developed by Prof. Walter Stahel. The waste hierarchy has shaped the understanding of the participants P15, P20, 21, 22, and P27. The idea of Doughnut economics appeals to participant P38, and she understands the circular economy in its reference.

The notion of profit followed and suggested by most participants is a mainstream one, except P13, P17, P40, and P20. They believe that a real circular economy is unachievable if the sole motive of a business is maximising revenues. For them, profit should include gross value added to the reserves of natural raw material resources and wellbeing of current and future generations.

6.3 Consolidating the sub-sections 6.2.1, 6.2.2 and 6.2.3

From the seventeen sub-categories presented in sub-section 6.1 and considering the steps four and five from the seven steps for investigating the circular economy (detailed in Chapter 3, sub-section 3.6), the sub-categories, which tells us more about the understanding of the circular economy across all the three cases are grouped as follows:

1. The circular economy understanding is as… (equivalent to step 4 – About the firm's understanding of the circular economy – see sub-section 3.6)
2. The circular economy is...,
3. The firm practices or operationalises the circular economy as, (equivalent to step 5 – About the firm's practice of the circular economy – see sub-section 3.6),
4. Traditional activities rebranded as a circular economy activity

The nodes in the above sub-categories were compared, which resulted in grouping the nodes under two main themes (a) the waste hierarchy and (b) an augmented waste hierarchy. A visual representation of the coding process is presented in Appendix 13. The coding map of both main themes is presented in figures 6-1 and 6-2 on the next pages. Figures 5-2 and 5-3 in Chapter 5 were also considered while developing the main themes, presented in the following pages.

The coding map of the first main theme, the waste hierarchy is presented in figure 6-1 and following it is the hierarchical organisation of thematic map of the waste hierarchy along with description of each codes is detailed in tables 6.4 and 6.4-1 below

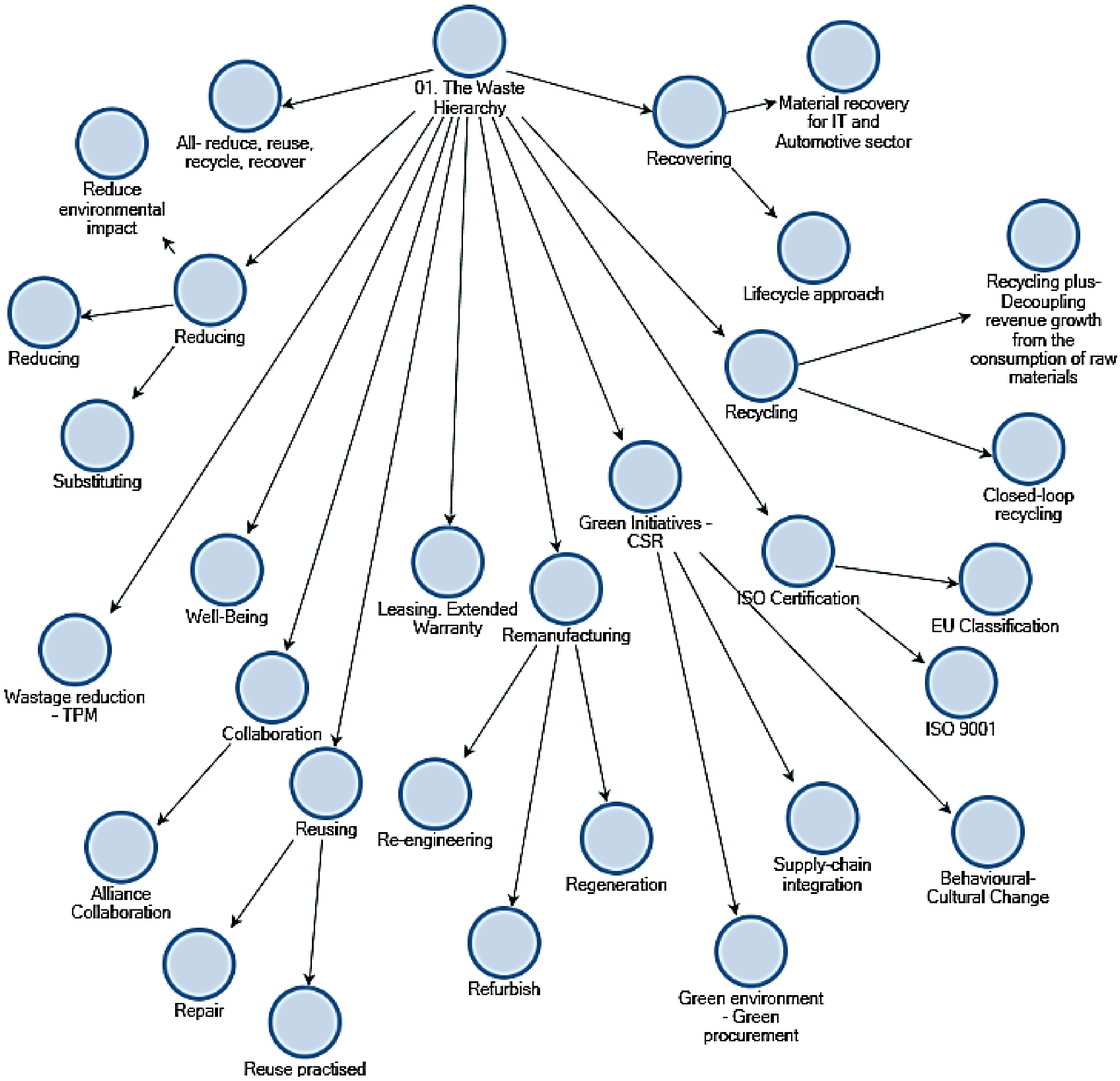

Figure 6-1: Coding map of main theme - the waste hierarchy

Table 6-4: Hierarchical organization of thematic map1: The Waste Hierarchy Part 1

Hierarchical Organization of the Thematic Map with Description of Codes – Part 1			
Main Themes	**Subthemes**	**Codes**	**Examples**
The Waste Hierarchy	Waste Hierarchy	The Lansink ladder	‘We are processing about a hundred and eighty thousand tonnes of waste-in-feed’ P32
	Reducing	Reduce environmental impact	‘We work very closely with the raw material producers both for the polypropylene resins and the paint systems, to make sure they’re applying environmentally friendly and REACH compliant materials to develop those products.’P34
		Reducing	‘When you recycle Aluminium you only...you save 95% of the original energy. So, if you compare against making more prime, recycle that's why it is recycling is so beneficial with Aluminium’ P01
		Substituting	‘substituting primary resource inputs for secondary material inputs for renewable material inputs. Substituting directly for renewable for non-renewable where possible and a whole range of actions that basically reduce overall demand to meet the value requirements that we get out of the products.’ P20
	Reusing	Refurbish/Re-use practised	‘I, again for my particular industry I’d say re- reuse’. P04 ‘It’s not necessarily reuse in the original application. it could be refurb and redirect in a way. But it’s primarily being able to use that inherent value in another manner’. P04.
		Repair	‘repair is still very much at the heart of the OEMs offering, particularly in B-to-B markets. P09
	Recycling	Recycling plus- Decoupling revenue growth from the consumption of raw materials	‘And so, circular economy is about recycling, but in my view circular economy if you remember, I said it was about doing-in affect doing more with less. So, it is decoupling revenue growth from the consumption of stuff, that is what recycling is, that we reduce our purchase of virgin materials by reintroducing secondary materials’. P11
		Closed loop recycling	‘before circular economy was really a term, I have not even heard of we just talked about closed loop being as sustainable as we could as a business.’ P01
	Remanufacturing	Remanufacturing	‘remanufacturing is probably the highest level of the circular economy.’ P08 ‘then the process goes into so after the entry test, we then, remanufacture the unit, towards the process that we have, and after remanufacturing, we test the unit again, we call that end of line test, EOL Test.’ P05
		Re-engineering	‘it’s a fundamental reengineering of product from the, um, from- from its conception all the way through to the lifecycle’ P18-B.
		Regeneration	‘So, the function of the heat battery is to be integrated into circuits and then to absorb the heat through the flow of that circuit and store it and then when it’s required, it has to reverse that process and to release the heat back into make the coolant circuit. Could be to fast warm up a cabin on a bus, or to fast warm up an engine, so acting as the medium to do that is the eco friendliness.’P26 ‘so, for me the circular economy is something that is regenerative’ P14
	Recovering	Material recovery	So in terms of material recovery let me- let me talk about, uh, let me talk about cartridges first, so the polypropylene and the PET. P11 ‘use that supply chain that we have already got that reverse logistics process, use it to extract the gold from. And then to use that gold that we extract and put that straight back into our products.’ P49

Table 6-4- 1: Hierarchical organization of thematic map1: The Waste Hierarchy- Part 2

Hierarchical Organization of the Thematic Map with Description of Codes – Part 2			
Main Themes	**Subthemes**	**Codes**	**Examples**
The Waste Hierarchy	Recovering	Material recovery	‘extracting the valuable parts of, let’s say a piece of electronic equipment which contains a lot of critical elements, usually in the form of metals, which are in danger of running out of easily available extraction. So, the more we use, I mean lithium for instance, cobalt, nickel, tungsten, tantalum, all those materials are used in for instance electronics’ P30
		Life cycle approach	‘I see circular economy as about a lifecycle approach to maintaining the value.’P20
	Collaboration	Alliance	‘We’re looking at enabling collaboration because we all know that the circular economy can’t be achieved by one organisation working by itself’ P06.
	Leasing\ Extended Warranty	Old concept	‘the circular economy is a newish term for things that have been happening for a long, long time so it’s described in many different ways within the ICT sector from leasing, companies like Xerox who are arguably some of the grandads of the leasing model are thriving through leasing..’P09
	Wastage reduction		‘to me productivity I’m defining it as the business side of things, which is of course, is eliminating waste’ P45
	Green Initiative - CSR	Green environment/ Green procurement	‘but I understand that aim is to do a green, you know, I suppose, the circular economy is another element of green procurement. So, you could buy sustainable products but from a linear model. So, you then you might buy your green product, but you know, you might have it as a service instead of buying the product. So, I think circular procurement builds on green procurement, if that makes sense.’ P06
		Supply-chain integration	‘And making sure that we have reliable suppliers. As the last thing we want to do is stop our manufacturing plants. We need to keep them supplied with parts, raw material and components to build the vehicles. So, to have a production stoppage is the last thing that we want. So, we have to work with reliable suppliers…use local suppliers wherever possible. So, suppliers that are close to our own manufacturing facilities. So, a lot of what we do is working with local suppliers to achieve the parts and the products that we want, so there is a minimum of transportation required.’ P34
		Behavioural -Cultural Change	‘we also need to think, ‘Is this right for this product, for the market that we’re targeting?’, and that often gets forgotten. So, Cardiff University are just doing some work at the moment on consumer perceptions of the circular economy.’ P17
	ISO Certification	ISO 9001	‘ISO 9001 is desirable because it shows the company is future thinking.’P33
	Well-being		‘well, there’s the prosperous Wales, the goal, I mean it all relates back to the well-being and happiness of individuals.’ P40

The coding map of the second main theme, the augmented waste hierarchy is presented in figure 6-2 and following it is its hierarchical organisation of thematic map along with description of each codes, detailed in tables 6-5, 6-5-1, 6-5-2, and 6-5-3.

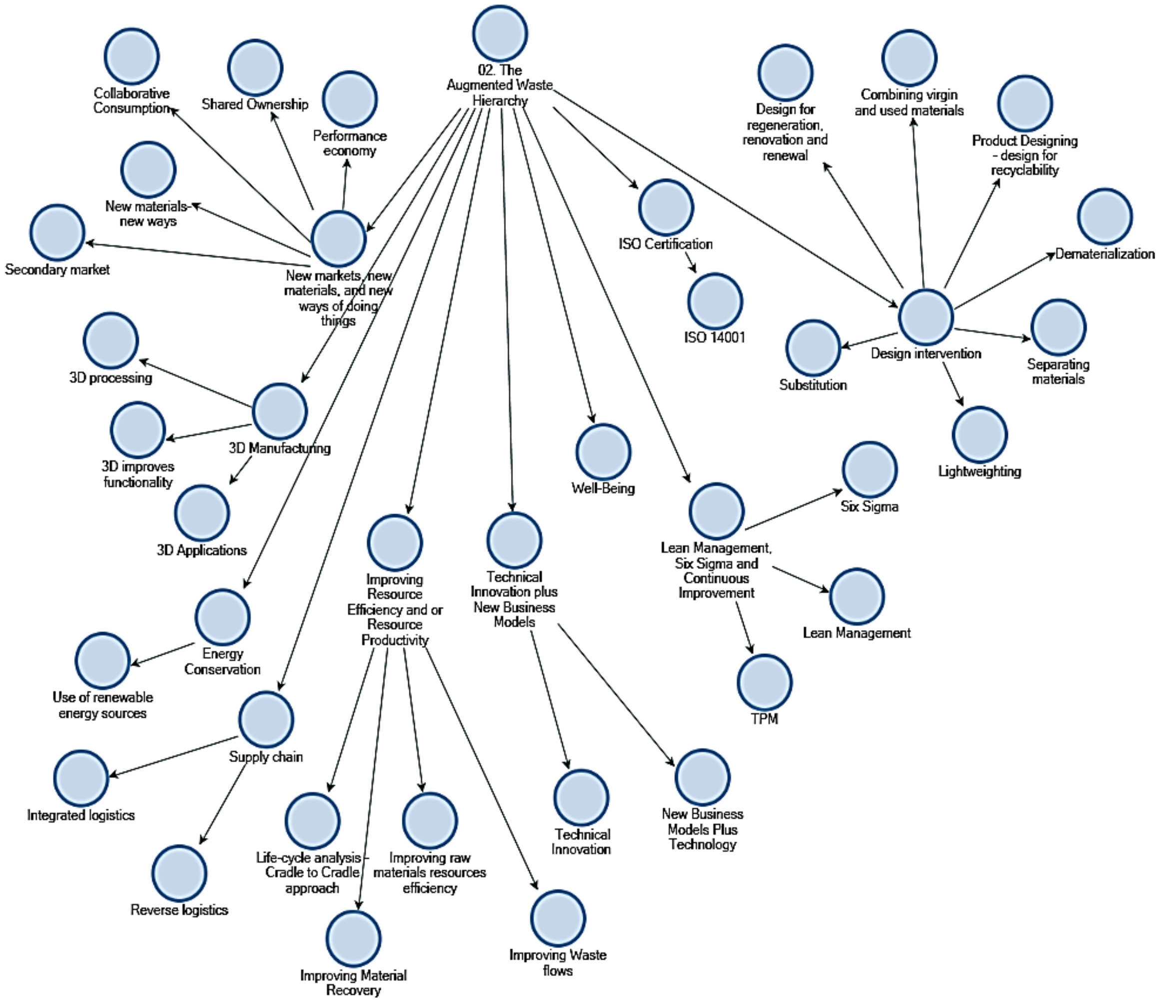

Figure 6-2: Coding map for the second main theme – the augmented waste hierarchy

Table 6-5: Hierarchical organization of thematic map 2: The Augmented Waste Hierarchy- Part 1

Hierarchical Organization of the Thematic Map with description of Codes Part 1					
Main Themes	Subthemes	Description	Codes		Examples
The Augmented Waste Hierarchy	Technical Innovation Plus New Business Models	To improve reducing, reusing, recycling of used raw materials resources.	Technological Innovation	Radical innovation	Phase change materials for storing wasted heat. .P26 Hydrogen fuel cell cars. P42
				Incremental innovation	'So, we had to make it what we call a 'remelt alloy' which made it much more suited to recycling.' P01
				Incremental innovation	'I'd need to have different manufacturing capabilities. So flexible manufacturing means having the ability to use hybrid manufacturing technologies, additive, subtractive, and automation in the right blend. So, erm, I could mass produce maybe the body, but 3D prints the grip and in electronics and circuitry if I need to. So, giving a manufacturer access to the whole range, so they can use hybrid manufacturing tec- techniques instead of just being good at additive or subtractive or robotics, it's the balance of those things by which we mean flexible.'P45
				Proprietary Technology	'We use so called BJEA rework technology.' P05 'We are also developing something called PBT, which is polybutylene terephthalate.' P03
			New Business Models plus Technology	Business model innovation	'the circular car can also be an easier platform to look into the future as in car sharing. This means that the manufacture will still be the owner of the car. So private ownership will disappear, and the manufacturer will use the car as a service' P05
				New Business models/ New markets	'We do not sell cars, we sell mileage, and if we can sell more miles with fewer cars, that obviously makes good business sense.' P42
	3D Manufacturing	Reduces the consumption of raw materials resources- It is additive and not subtractive manufacturing	3D improves functionality, compresses time, reduces money		'For brand new the functional process clicks in it's the car seeing if all these components are correct in the right place. If you gonna go tooling for that it would be a massive expense. Massive expense, so to build it on a machine like this is a fractional cost maybe a tenth of the cos.' P03
			3D Applications		'we are using our own 3D printing to print our own spare parts for example, so that's- that is one thing. But I think there are wider constructs around 3D printing in with regard to circular economy, and a lot of it is to do with spare part manufacturing.' P11
			3D Processing		'we have seen a massive decrease in traditional metal parts being replaced with polyamides. So, there's more plastic parts.' P03

Table 6-5 1: Hierarchical organization of thematic map 2: The Augmented Waste Hierarchy- Part 2

Hierarchical Organization of the Thematic Map with Description of Codes Part 2				
Main Themes	**Subthemes**	**Description**	**Codes**	**Examples**
The Augmented Waste Hierarchy	Design Intervention	Improves reduction, reuse, recycling, recovery, of raw materials resources.	Substitution	‘we have seen a massive decrease in traditional metal parts being replaced with polyamides. So, there's more plastic parts.’ P03
				‘The majority of it, as I mentioned, is polypropylene. But we will also use polyamide material. That’s probably the second largest volume.’ P34
			Combining virgin and used materials	So, we were able to recycle 90% of material and then we top up the 10% fresh material. Which means over the period of time, the return of investments in machine is that you’re using less new powder.’ P06
			Design for regeneration, renovation, and renewal	‘So again, in terms of the design, if I can design a product that is ease of repair, replacement, maintenance, as much as initial manufacture, ultimately it does drop out in cost as well.’ P04
			Design for recyclability	‘we’ve changed our design philosophy, our materials sourcing philosophy and linked ourselves in with the resource recovery industries such that seventy-five percent of our car is now traceable certified closed-loop recycled material,’ that to me would be a pretty good circular performance. And I think that organisation, if it was an early mover in their sector, should get a fiscal benefit for having done that.’ P32
			Dematerialisation	‘We want a really simple bill of materials on cars. We want components that are designed to be releasable and come apart. We don’t want complex multi-layer things like hemp and carbon fibre in a thermosetting plastic.’ P32
			Separating materials	‘That fires x-rays into the polymer. And that lets you spot any traces of heavy metals or halogenated flame retardant. So, you’re looking for traces of legacy additives that you don’t want in the new polymer.’ P32
	Improving Resource Efficiency and, or Resource Productivity	To benefit from waste flows, reducing dependency on virgin raw materials resources either through recovery or recycling.	Improving waste flows	‘to deliver value to the customers and that is the, you know, the model that says it's designed to last, it's designed to be repaired, it’s designed to be disassembled, it's designed to be recycled, so that the resources stay in use for much, much longer. Now I would expect businesses that don’t do that to not be competitive.’ P16
			Improving raw materials resources efficiency	‘I think businesses understand resource efficiency, they understand I think resource productivity. We- we’ve seen for years these- you know previously these incremental increases in resource efficiency at plant level, efficiencies in how you know we might reduce exp- dependency on expensive materials.’ P09
				‘you increase productivity, by using digitalisation and robotics.’ P33

Table 6-5 2: Hierarchical organization of thematic map 2: The Augmented Waste Hierarchy- Part 3

Hierarchical Organization of the Thematic Map with Description of Codes. Part 3				
Main Themes	**Subthemes**	**Description**	**Codes**	**Descriptions**
The Augmented Waste Hierarchy	Improving Resource Efficiency and, or Resource Productivity	To benefit from waste flows, reducing dependency on virgin raw materials resources either through recovery or recycling.	Improving material recovery	-'we setup, an internal group where we had a big cross functional group assembled. So, we would have people asset recovery and global Dell outlet business. We would have asset resale and recycling side. We also had people from the sales team, from the Dell financial services, and they were the ones that offer the leasing programmes. So we'd bring everybody together under this one, as well as having supply chain and product compliance, and the sustainability team, pulled into it as well' P49.
			Life-cycle analysis – Cradle-to-Cradle™ approach	'That's why you have to consider everything as a lifecycle analysis to make sure it's a complete cradle to grave consideration of the material, the components, the application and how it's recycled.' P34
	New markets, new materials, and new ways of doing things. Performance Economy	To create an infrastructure that promotes recycling and create new materials that are recyclable. New ways of doing things based on performance of the product. Reducing consumption	Secondary markets	'The idea was to try, originally was to reduce the volume of waste and decouple from environmental growth because obviously, originally, the more the economy grew the more waste grew it was to originally decouple those and then develop markets for secondary materials etc and obviously there was the kind of the, any sort of industrial sort of processes that you could link together in terms of somebody's waste becomes somebody's feed stock' P36
			New materials/ new ways	'the fourth industrial revolution allows a batch size of one' P33
			Collaborative consumption	'the stable clothing action plan we've just charged our reuse and recycling working group with developing a road map to looking at how we can increase reuse and recycling in the UK.' P17 'I think part of that is about uh about another thing which is about resource sharing and collaborative consumption.' P20
			Shared ownership	'we move to a more uh, move away perhaps from a behaviour norm of ownership to perhaps shared assets and-and leasing and that kind of thing.' P22
			Servitization – Product as service	'the car will become "a service" instead of a privately owned car' P05 'Nobody else sells ink as a service like we do.' P11
			Sell less	'through our Courtauld commitment, I've gone to supermarkets and said, "I would like you to sell less food, please. What do you think?" And they have said, "Okay."' P16
			Doing more with less	'There is doing more with less' P11

Table 6-5 3: Hierarchical organization of thematic map 2: The Augmented Waste Hierarchy- Part 4

Hierarchical Organization of the Thematic Map with Description of Codes. Part 4				
Main themes	**Subthemes**	**Description**	**Codes**	**Descriptions**
The Augmented Waste Hierarchy	Lean Management, Six Sigma and Continuous Improvement	Lean Management Six Sigma	Lean management	‘back to a lean methodology, find out where your waste is going and remove your waste.’ P04 ‘we start by looking at where is their waste. There’s wasted time, there’s wasted material, there’s wasted processes, and we start taking those things away, we start to introduce certain levels of automation.’ P45
			Six Sigma	‘You know, we look at our utilisation of things like water and electric, we look at our material utilisation, so again, we try not to build any waste into our process. I think that’s the same for any, any manufacturer nowadays, everyone talks about Lean Manufacturing and Six Sigma and, you know, so it’s constant improvement, constant measures, constant driving down costs and driving out waste.’ P08
	Supply chain	Supply chain helps in bringing back the used raw materials resources for reusing, recycling, remanufacturing, and recovering	Reverse logistics	‘so, I think reverse logistics is a core element.’ P09 ‘manufacturing sectors is making sure that there’s enough core coming back to remanufacturing plants in a sufficiently predictable way to support a manufacturing process so I think that’s a massive issue, and actually the kind of delivery of that product, the reverse logistics of that product, how can you make sure that is done in a-in a cost-effective way.’ P09
			Integrated logistics	‘Like I said in the supply chain, they need to find a connection with the manufacturers, so they need to be a supplier to the manufacturer or need to be approved by a manufacturer. They need to innovate, and like I said they need to be proactive instead of reactive. If they have a close relationship with the manufacturer, the manufacturer can tell them what them what the demand of the future will be.’ P05 ‘We've got integrated logistics that take that scrap out of 16 of their press shops, back into our process.’ P02
	Energy Conservation	To reduce entropy and GHG emissions	Use of renewable energy resources	‘So, I think all the things that make up the- the principle of circular economy, renewable energy for example.’ P14
	ISO Certification	Standardization of process for uniform implementation	ISO 14001	‘that wants to be circular should be certified by a ISO14001 Standard and TS16949 I think it is, so therefore, especially with ISO environment standards everybody needs to work towards that, and I think even that with circular cars these environment standards.’ P05
	Well-being	Caring for the present and future generations		Well-being of Future Generation (Wales) Act 2015 Seven well-being goal and five ways of working. P40

6.4 Part 2: Analysis of Findings of Inter-Sectoral Comparisons

From the below Table 6-4, the participants from across the automotive, IT firms and Government agencies hold the view that the circular economy is not a new concept and a confusing term.

Table 6-6: Comparing views about the circular economy across the three cases

Comparing responses from across the Automotive, IT firms and Government Agencies				
Sub-theme		Automotive	IT	Government
The circular economy is	The circular economy is a buzzword, complex and an old concept.	P1, P2, P4, P5, P8, P30, P32, P34, P47+48	P3, P9, P11, P14, P18, P33, P45, P49	P6, P13, P15, P16, P17, P20, P21, P22, P24, P27, P28, P29, P36, P38, P40

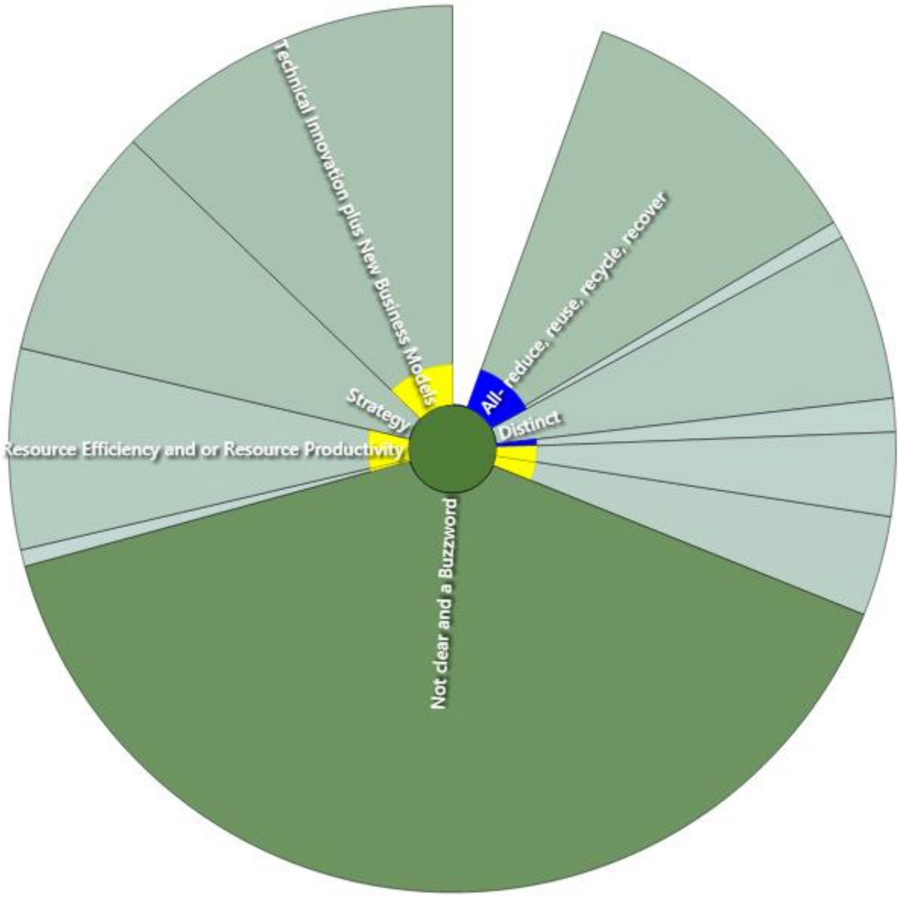

Figure 6-3: Hierarchical chart of nodes coded at the sub-theme – 'The circular economy is'

From table 6-6, and figure 6-3 above (summary of coding references, aggregate number of items coded in this node is presented in appendix 16) , we know that among other things, almost ninety-seven per cent of the participants across the three cases view the circular economy as a buzzword, complex and difficult to understand.

The different understandings of the circular economy, detailed in Table 6-5 below, are as per each firm adapting it to their business requirement.

Table 6-7: Comparing an understanding of the circular economy across the three cases

Comparing different understandings			**Occurrence in Cases**			
	B. The participants understand the circular economy as:	**Business Focus**	**Automotive**	**IT**	**Government**	**Main themes derived from tables 6-4s and 6-5s above**
1.	(a) Recycling, Re-using, Recovering and remanufacturing (In the case of Government sector participants, it is about implementing the Waste Hierarchy)	Remanufacturing	P4, P5, P8, P34	P9, P11, P49		
		Recovery	P26, P34	P49		
	(b) Recycling Plus: Decoupling revenue growth from the consumption of resources	Recycling Plus		P3, P9, P11, P14, P18	P6, P13, P38, P40	The Waste Hierarchy
2.	Reducing Waste (in Auto and IT sector; Reducing Consumption (in Govt. sector)	Waste reduction	P1, P2, P4, P5, P26, P30 P34		P16, P17	
3.	The Waste Hierarchy				P15, P16, P17, P20, P21, P22, P27, P28, P29, P36, P38, P40	
4.	Product Designing	Includes designing raw material resources	P1, P2, P30, P32, P34	P11, P45	P14	
5.	Technical Innovation	Technological innovation plus business model innovation	P42	P3, P33	P13, P20	
		Technological innovation only	P1, P5, P32, P34	P2, P33		The Augmented Waste Hierarchy
6.	Servitization and, or, altering business models		P5, P42	P33	P40	
7.	Lean Management, Six-Sigma, and Continuous improvement	Automotive engineering orientated - Driving out wastages in processes	P4	P33, P45		
8.	Energy Conservation	Storing wasted energy	P26			

The best way to describe different understandings of the circular economy across the three cases is via two main themes, that is, (a) the waste hierarchy, and (b) the augmented waste hierarchy. Understanding the circular economy as a waste hierarchy means following the recommended 4Rs in sequential steps, such as reduce, reuse, recycle and recover, including directing wastes away from landfill. Whereas understanding a circular economy via the augmented waste hierarchy is about exercising the powers of technological innovation and different management capabilities for realising/ actualising the waste hierarchy. Such an understanding often results in compelling the firms to alter its business models. The two main themes reiterates that the circular economy is not a new concept or phenomenon. Instead, the structure of the conventional waste hierarchy has transformed. It is so because the purpose behind the augmented waste hierarchy is to use technology/innovation to delink the consumption of the raw materials resources through reducing, reuse, recycle or recover processes from revenue growth. In this sense, the circular economy brings dynamism to the conventional structure of the waste hierarchy making it a lucrative business proposition.

In the automotive firms, twenty-four per cent of firms investigated understand circular economy from a recycling perspective, focusing primarily on remanufacturing, which is one form of recycling. Whereas among IT firms, sixty-three per cent of participants align their understanding of '*recycling plus*', i.e., decoupling revenue growth from consuming raw material resources. Eighty per cent of the government agencies' participants understand the circular economy in terms of the traditional waste hierarchy. Among the three cases, the IT firms have emerged to be more aware of and have an enhanced understanding of the circular economy, making it a highly responsive and dynamic model.

How the investigated firms realise/ actualise their understanding of the circular economy is reflected in their actions, as shown in Table 6-8 below. The Government agencies are not in this comparison as they are involved in structural and legislative initiatives for realising benefits of the circular economy.

Table 6-8: Comparing the practices of the circular economy across the three cases.

C.	**Comparing the practices of the circular economy**	**Occurrences in cases**			
		Automotive	**IT**	**Government**	**Main themes derived from tables 6-4s and 6-5s above**
1	Remanufacturing	P4, P5, P8, P34	P11, P49		Waste hierarchy
2	Closed loop recycling	P1, P2, P5, P32, P34, P47-P48	P11, P14, P18, P49		Waste hierarchy
3	Lean management. Six-Sigma and Continuous Improvement.	P4, P34	P33, P45		Augmented waste hierarchy
4	Designing materials	P1, P30, P32, P34	P3, P11, P45		Augmented waste hierarchy
5	Recovery of materials/Improving raw materials productivity /Waste data	P5, P32, P34	P49	P22	Augmented waste hierarchy
6	Technological innovation	P42	P3, P11, P33		Augmented waste hierarchy
7	Storing wasted energy/use of renewable energy	P26	P14, P18,P49		Augmented waste hierarchy

It is evident from Table 6-8 above that, about sixty-four per cent of the automotive firms practice the circular economy as closed-loop recycling, while fifty per cent of the IT firms practise closed-loop recycling in the form of the traditional waste hierarchy. Thirty-six per cent of the automotive firms and twenty-five per cent of the IT firms engage in remanufacturing. Although recycling drives both closed-looping and remanufacturing, neither is irreducible to the other. That is, both are two distinct sets of activities.

Understanding the circular economy is much advanced among the IT firm participants, but it does not get translated into practice. That is, there is a gap in terms of knowing and doing. The circular economy's understanding is about closed-loop recycling and is translated into practice quickly in automotive firms. However, they are far from being genuinely circular because moving away from using virgin raw material resources is still far away from being a reality, despite they engaged in high recovery activities at twenty-seven per cent, as opposed to thirteen per cent of IT firms.

Technological innovation is high in the IT firms, with thirty-eight per cent of firms engaging in innovation activities in terms of designing materials and finding new materials to substitute for a scarce resource; while innovation activities are slow in the automotive firms, with only nine per cent of firms engaging in radical innovation. The reasons for high innovation in IT firms is because (a) the business environment is turbulent as a result of intense competition and innovation is necessary for survival, (b) there is increasing pressure to maximise resources productivity and profits, and (c) this necessity has led innovation to become an integral part of the tech sector. Such technological innovation compels firms to look for alternative business models to encourage innovation.

Table 6-9 below presents all those traditional activities that are re-branded as a circular economy activity. Supply chain integration (both forward and reverse) and interdepartmental, and cross-firm collaborations have more weight (fifty-five percent) in automotive firms, whereas only supply chain is branded as the most critical activity by fifty per cent of the IT firms for implementing the circular economy. There is no mention of interdepartmental collaboration between the different government agencies. The Government agencies emphasise implementing the waste hierarchy (about forty per cent) in any form.

Thirty-seven per cent of the automotive firms consider the circular economy to be a policy instrument, whereas fifty per cent of IT firms hold this view. Forty-six per cent of the government agencies consider the circular economy as a policy while formulating the environmental policy.

Table 6-9: Comparing traditional activities rebranded as a circular economy activity

D. Comparing the traditional activities that are re-branded as a circular economy activity			**Automotive**	**IT**	**Government**	**Main themes derived from tables 6-4s and 6-5s above**
1	Leasing/Extended warranty		P1, P5, P34	P11, P49	P38, P17	Waste hierarchy
2	Implementing waste hierarchy				P16, P42, P27, P28, P29, P36	Waste hierarchy
3	Supply-chain integration (both forward &reverse), Green procurement		P1, P2, P5, P8, P32, P34	P11, P14, P18, P49	P6, P13, P16, P24	Waste hierarchy
4	Wastage reduction		P1, P2, P4, P30		P24, P20, P21	Waste hierarchy
5	Interdepartmental/cross-sector collaboration		P1, P5, P8, P32, P34, P42	P49		Waste hierarchy
6	A policy instrument- A vision, A concept where serious money is involved		P1, P34, P5	P11, P49, P14, P45	P13, P16, P17, P20, P26, P36, P38	Waste hierarchy
7	A concept that promotes the well-being of future generations				P40	Waste hierarchy
8	Behavioural change initiatives		P4		P21	Waste hierarchy
9	Life-cycle Analysis		P1, P2, P5, P34, P42	P45		Augmented waste hierarchy
10	Proprietary technology development/Digitisation/Digitalisation		P1, P5, P30, P32, P34, P42	P9, P13		Augmented waste hierarchy
11	Certifications	ISO 14001	P1, P8, P5, P32			Augmented waste hierarchy
		ISO9001	P5, P30, P33			Waste hierarchy
		EU Classification	P47, P48			Waste hierarchy
12	Reducing consumption				P16, P17	Augmented waste hierarchy
13	New markets, higher efficiency, resource savings, ways to achieve competitive advantage				P6, P13, P16	Augmented waste hierarchy

Other activities such as life-cycle assessment (forty-five per cent), waste reduction (thirty-six per cent), and proprietary technology development (thirty-six per cent), are critical for the implementation of the circular economy in the automotive firms. In the IT firms, leasing / extended warranty (twenty-five per cent) and proprietary technology (twenty-five per cent) are central to implementing the circular economy.

After having identified the rebranded traditional activities and weight given to each for implementing the circular economy, it is worthwhile to explore how waste gets handled in the context of the circular economy.

Table 6-10: Comparing implementation of the waste management across the three cases.

E.	Comparing the seriousness in implementing waste management	Occurrences in cases		
		Automotive	**IT**	**Government**
1	Environmental policy	P2, P34	P14,P18,P33,P45,P49	
2	General waste policy	P1,P5,P8,P32	P11	
3	EU Regulation	P47, P48	P11	
4.	Not taken seriously – A routine activity	P05, P26, P04	P9	

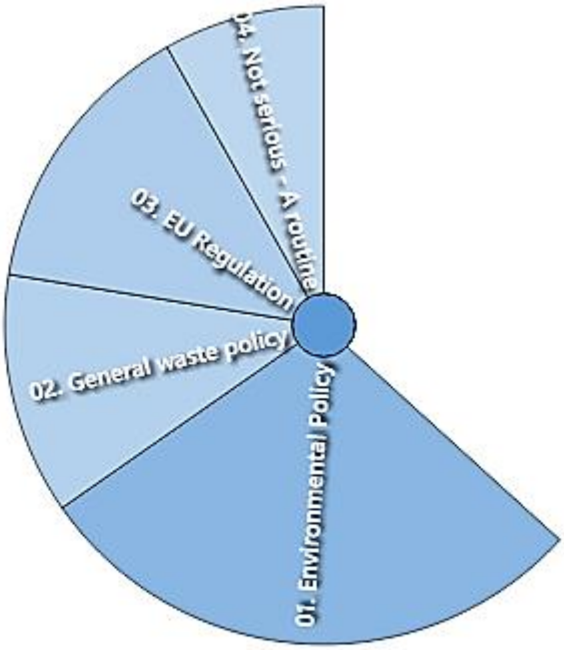

Figure 6-4: Hierarchical number of items coded at 'The seriousness in implementing waste management'

The automotive firms manage their wastes through a general waste management policy (thirty-six per cent). In contrast, in IT firms, waste management is covered under the environmental policy (sixty-three per cent) presented in Table 6-10 above. In both automotive and IT firms, environmental policy gets implemented more than others, such as general waste policy or EU regulations as coded in figure 6-4 (see details in Appendix 17). In many automotive firms, waste management is not taken seriously and is routine without much impact. The number of coding references, along with the number of items coded and the aggregate number of items coded at this node, is presented in Appendix 17

The literature review shows that several authors had found different influences on the definition of the circular economy. Lieder and Rashid (2016); Geissdoerfer et al. (2017); Kirchherr et al. (2017). With this view, the author compared the different influences found across the three sectors, presented in Table 6-11 below.

Table 6-11: Comparing the different influences on the understanding of the circular economy

F.	Comparing the different influencers on the understanding of the circular economy	Occurrences in cases		
		Automotive	**IT**	**Government**
1	Ellen Mac Arthur Foundation: member of CE100, McKinsey	P1,P2,P8,P34	P11,P14,P18,P49	P6,P13,P27,P28, P36,P40
2	Performance economy – Prof Walter Stahel	P42	P11	P16, P17
3	Life-cycle Analysis - Not limited to the Cradle-to-Cradle concept alone.	P42, P34	P45	
4	Lean management/Six sigma/Continuous Improvement	P4, P8, P30		
5	Technological advancement		P3,P33,P45,P49	
6	Accenture		P49	
7	**Waste hierarchy**			
8	The natural capitalism	P42		
9	Doughnut economics			P38
10	Resources scarcity plus 2007-08 economic recession	P5, P8,P26,P30,P32	P9	P27, P28

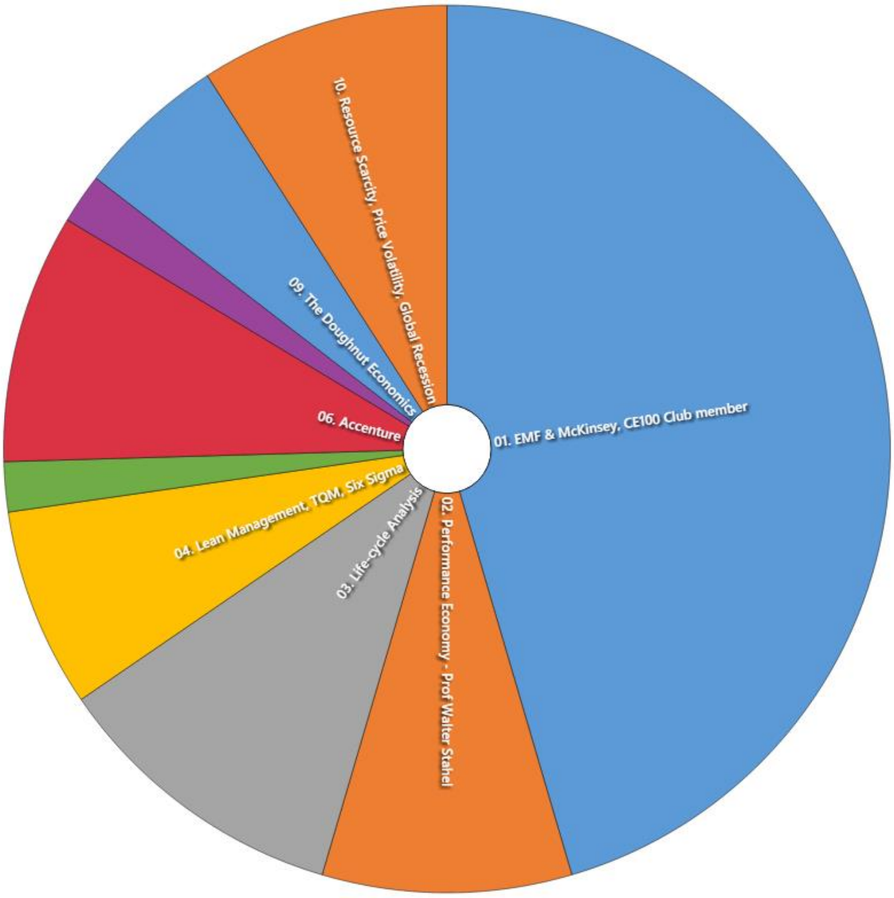

Figure 6-5: Coding map for the primary influencer in the understanding of the circular economy

It is evident from table 6-11 and figures 6-5 (the details of coding references and the aggregate number of items coded at this node is in Appendix 18) that the EMF's definition influences about forty-one per cent of the participants' understanding of the circular economy across the three cases. The other significant cause for companies looking to delinking economic growth from resource consumption is resource scarcity and the 2007-08 economic recession.

Forty-five per cent of the automotive participants' understanding of the circular economy stems from the resource's scarcity and high volatility of the prices of the resources, including the opportunities it offers to save resources. Thirty-six per cent of the automotive participants and fifty per cent of the IT firm participants were directly under the influence of the Ellen MacArthur Foundation's definition. In contrast, forty-per cent of participants from the government agencies were under the influence of the EMF's definition.

The other influencers are the Performance Economy, the Life-cycle Analysis but not limited to Cradle to Cradle™ alone and Advanced Technology. Additionally, a few noteworthy influencers are concepts that do not fall under any of the EMF's house of concepts[46], and these are Sir Paul Hawkins' Natural Capitalism, Kate Raworth's Doughnut economics, and Lean Management Techniques. The performance economy has influenced only thirteen per cent of participants' understanding in IT firms and the Government agencies. Similarly, Doughnut economics influences only seven per cent in the government sector. Cradle-to-Cradle ™ is a certification process, which includes life-cycle assessment, and influences about eighteen per cent in automotive, thirteen per cent in IT firms, and has no influence in the government sector. Another definition that influenced thirteen per cent of participants' understanding in the IT firms is offered by Accenture, which centres on circular business models and talks of circular competitive advantage. Lean management, Six sigma, and continuous improvement influences twenty-seven per cent of participants from the automotive firms alone.

To diagnose the major influencer and reduce the clutter of who is, in reality, influencing the circular economy's understanding, the author applied the concept of absence and negation from the Critical Realism tools detailed in chapter 4. Therefore, a further comparing and contrasting the Tables 6-7, 6-8, 6-9 and 6-10 ensued. It resulted in detecting four absences, presented below:

1) **Absence 1:** Table 6-7 presents evidence that a majority of the participants understand the circular economy from a recycling perspective or similar to recycling. Not a single participant says that he/ she understands the circular economy as a waste hierarchy or from the perspective of a waste hierarchy, although all understandings are shaped by the 4Rs processes of the waste hierarchy.

[46] EMF's House of Concepts includes the performance economy, Cradle-to-Cradle™, Bio-mimicry, Industrial Ecology by Ried Lifset, and Blue Economy Systems by Gunter Pauli.

2) **Absence 2:** Table 6-8 provides evidence that the practice of the circular economy takes different forms such as recycling, recovery, closed-loop recycling, designing out waste or reducing the use of resources. There is a complete absence of mentioning the waste hierarchy despite it underpinning all the practices.

3) **Absence 3:** Table 6-9 lists all those traditional activities rebranded as a circular economy activity. There is again a complete absence of participants reporting rebranding carried out for implementing the waste hierarchy.

4) **Absence 4:** Table 6-11 compares the different influencers impacting a participant's understanding. Once again, there is a complete absence of any participants reporting the waste hierarchy influencing his/her understanding of the circular economy. The government agencies participants prefer to use the term 'resource efficiency' or 'resource productivity' instead of the circular economy. They do not mention waste hierarchy even though they often refer to waste hierarchy while explaining their understanding of the circular economy – *c.f.* table 6-9.

Despite these absences in participants' narrations, there is a conspicuous presence of the waste hierarchy in practice. The identification of the absence of a waste hierarchy underpinning in participants' responses is consistent with the main themes that resulted from grouping the different understandings. The absences also unveil the constructivist approach to the circular economy narrative.

Table 6-12 and figure 6-6 below presents the different views about the firms' logic of profit expressed by the different participants across three cases. A summary of references coded in this node is presented in Appendix 19, and a representative sample of references coded at this node is presented in Appendix 20.

Table 6-12: Comparing the views on the logic of profit across the three cases

G. Comparing the views on the logic of profit		**Occurrences in cases**		
		Automotive	**IT**	**Government**
1	Mainstream =revenues (minus) costs	P1, P2, P4, P5, P8,P26,P30,P32,P34, P42,P47,P48	P11, P49	P6, P16,P36,P38
2	Value-added to the economy/Change of accounting principles for CE	P42	P9, P14, P18, P45	P13, P17, P20
3	Value in terms of the well-being of employees and future generations - People, Profit and Planet	P30, P42	P3, P9, P33, P45	P27, P28, P29, P40

Many of the participants' followed the mainstream logic of profit, i.e., maximising revenues for themselves as well as for their shareholders, e.g., ninety per cent of the participants in the automotive firms were on the mission to maximise profits, come what may.

About fifty per cent of the participants from IT firms recognised that while profit maximisation is a necessary condition for the firm to be in business, thinking about value addition to the economy is equally important.

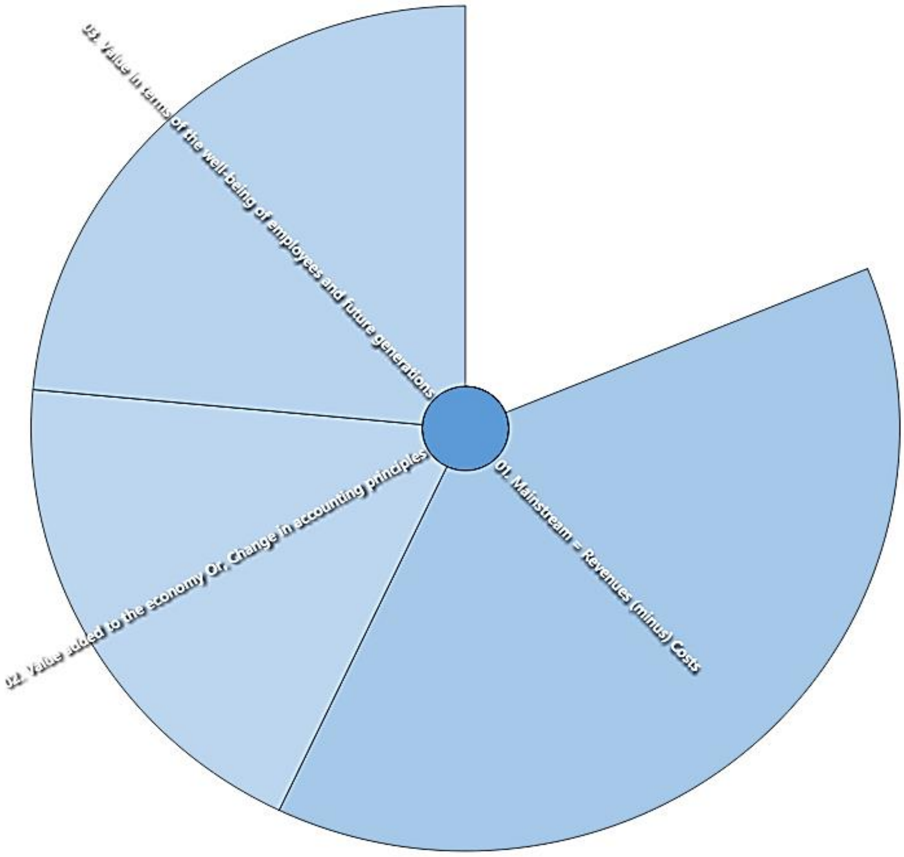

Figure 6-6: Hierarchical coding for the logic of profit compared by number of items coded.

Almost all participants agree to consider the wellbeing of employees and generational equity, as components while calculating value added to the economy. In this regard, some suggestions that participants put forth are worth considering. The most significant is the need to change the existing accounting principles to include:

a) Internalising environmental damage instead of rewarding higher consumption in any form - whether in products or raw material resources.

b) To keep the used resources/ products in the accounting books of the manufacturer or owner, even when these are physically in other sites, e.g., in the recycler's premises or with any other supply chain partners. Such an accounting model would require re-thinking the existing ownerships models and property rights legislation.

The views of the participants from government agencies were mixed - twenty-six per cent of the participants favour maximising revenues, while about the same percentage of participants favour value addition to the economy in terms of the wellbeing of employees and generational equity. There were about thirty-three per cent of the participants who chose to deflect the question.

6.5 Discussion 1: About an understanding of the circular economy

Although the term 'waste hierarchy' is absent from participants' responses, the circular economy at the firm level is operationalised as a waste hierarchy. Furthermore, all participants across three sectors have confirmed that they understand the circular economy either in one or more forms, such as (a) recycling, (b) closed-loop recycling, (c) re-use, (d) reducing waste, (e) designing materials, (f) finding innovative solutions for achieving zero-waste, (g) servitization, and (h) altering the business models as Tables 6-7, 6-8, 6-9 and 6-10 disclose. The waste hierarchy underpins all these forms of understanding. Therefore, it is fair to conclude that the reality of the circular economy is a waste hierarchy, manifesting itself in the form of the augmented waste hierarchy. This conclusion is consistent to Kirchherr et al. (2017) as they identified the 4Rs as the core principles of the circular economy, but Kirchherr did not conclude that the reality of the circular economy is a waste hierarchy. The emergence of an 'augmented waste hierarchy' is consistent with the identified higher-order themes. Thus, this ends the search for a realistic concept that best describes the circular economy that started in Chapter 2. Such varied descriptions of the circular economy help in identifying its characteristics, explicated in subsequent paragraphs. This conclusion is consistent with Williams (2015) assertion that long before the rise of the circular economy to answer sustainability problems, the waste hierarchy had a similar task. A waste hierarchy offers a more explicit priority, via the hierarchy following the order of treatment of resources in the economy: prevent or reduce the amount of waste, reuse, and recycle materials, incinerate with heat recovery, and landfill.

The circular economy literature review identified the drifting away of the circular economy from its environmental and societal remit, focusing on the economics aspect alone, according to Kirchherr et al. (2017), following Geissdoerfer et al. (2017) and Lieder and Rashid (2016), and others. Contrary to this claim, the absences reveal the constructed reality of the circular economy narrative, i.e., renaming the waste hierarchy as a circular economy, and distancing it from the environmental and societal dimensions. Therefore, the circular economy is still a paradigm that has the potential to address all three dimensions, as opposed to the UN Sustainable development programme, which supposedly fails to address the economic dimension.

A closer look at the journal articles gives the impression of circular economy drifting and reveals that the authors of such journal articles are a part of the paradigm community, or their University is a part of the network of Universities under the EMF umbrella.

The institutionalised absenting of the waste hierarchy as found in the participants' responses are quite intriguing. This research shall endeavour to address it by developing a plausible explanation for the current understanding of the circular economy through systematically combining both inductive and deductive logic (Dubios and Gadde, 2002).

6.5.1 A plausible explanation for the current state of understanding of the circular economy

The replacement of the waste hierarchy term with the circular economy, and the emergence of an 'augmented waste hierarchy' signifies that waste hierarchy has undergone, or is undergoing, a structural elaboration, if we look at its change from the perspective of the transformational model of social activity (TMSA)(Archer, 1995; Bhaskar and Lawson, 1998). The reality of the circular, the empirical traces found in the historical roots of sustainable development in Chapter 2, and the relationship of business with waste, allows us to offer an explanation of the current confusion relating to the understanding of the circular economy, and how it gets linked to UN Sustainable development.

The waste hierarchy's structural elaboration takes the conversation back to the second industrial revolution, or even further back in time to the early 18th century when reuse of waste was widespread[47] and played an essential role in industrial development. During that time, waste was more important than the environment. Consequently, the observed regularities and patterns shown in the augmented waste hierarchy or a circular economy could be a former reuse activity. The current promotional activities carried out by the NGOs, big consultancy firms, and government agencies, to project it as a panacea for addressing the resources problems faced by the UK manufacturing sector, has conditioned a conventional waste hierarchy. In so doing, it reopens the muted portions of the Lansink ladder[48], which are environmental protection, reduction in energy use, and the emphasis on considering thermodynamics and planetary boundaries. The latter has been replaced with social and generational equity in a circular economy context. Due to similar aims, and a lack of distinct demarcations, a circular economy becomes linked to UN Sustainability, making both contested concepts.

[47] R.W. Hofmann speech about no waste in a chemical factory in 1848 and more recently O'Brien's (O'Brien, 2008) work on Crisis of waste.
[48] Ad Lansink created a schematic representation of the waste hierarchy

The timing for renaming the waste hierarchy as a circular economy is just right, because there is a growing view that the waste hierarchy in its current form is unable to achieve absolute reductions in resources use. When compared to the circular economy, a waste hierarchy has shortcomings, and these include a lack of incentives for following the order of treatment of resources in the waste hierarchy, as well as lack of clear guidance and policy support. Also, a waste hierarchy does not necessarily save natural resources, either in theory nor as practised by policy (Cecere et al., 2014; Gharfalkar et al., 2015; Van Ewijk and Stegemann, 2016).

The structural transformation of the waste hierarchy has considerable implications across different dimensions and in the understanding and practice of the circular economy. For instance, the addition of the environmental aspect to the waste hierarchy shows the empirical traces of the environmental movement of the 19th century found in the historical traces of sustainable development.

Furthermore, the inclusion of social and generational equity links it to the empirical traces of the political economy of the late18th-early19th century that resulted from the issues of the morality of wealth accumulation, again relating it to the historical root of sustainable development (Harlow et al., 2013).

Additionally, protecting the environment and the reserves of natural resources has its backgrounds in faith philosophies (Von Wright, 1997 p. 5). Sustainable development also has similar roots in faith philosophies (Du Pisani, 2006). Gladwin et al. (1995) has highlighted that there is a separation of truth from morality, and humanity from nature in the management practices, suggesting integration of both to support sustainable development. The central theme in the virtuous acts is moral values (Nisbet, 1980 pp. 77 & 100).

It is the adding of environmental protection, social and generational equity to the waste hierarchy, and then its renaming as a circular economy that confuses a non-specialist. They often try to see the circular economy in the light of the UN Sustainability Programme. Such types of confusion were also evident amongst managers in the Case companies investigated, shown in Table 6-11 and figure 6-7 below.

Table 6-13: Comparing participants' views about UN Sustainability and the Circular Economy

Contrasting participants views about UN Sustainability and the circular economy.		Occurrences in cases		
		Automotive	**IT**	**Government**
1	Sustainability is an overarching concept	P1,P2,P8,P32,P34,P42	P3,P9,P11,P14,P18	P15,P16,P17,P20,P21,P22,P24,P27,P29,P36,P40
2	The circular economy is an overarching concept		P45, P49	
3	No views on sustainability and circular economy	P4,P5,P26,P47,P48	P33	P6,P13,P38
4	Sustainability and circular economy are the same	P30		P28
5	Circular economy is an evolution (environmental policy or waste policy)	P1,P2,P4,P5,P8,P30,P32,P34	P11,P14,P18,P49	P6,P13,P15,P16,P17,P20,P21,P222,P27,P29,P36,P38,P40
6	Circular economy is an revolution	P42	P3,P9,P33,P45	P13

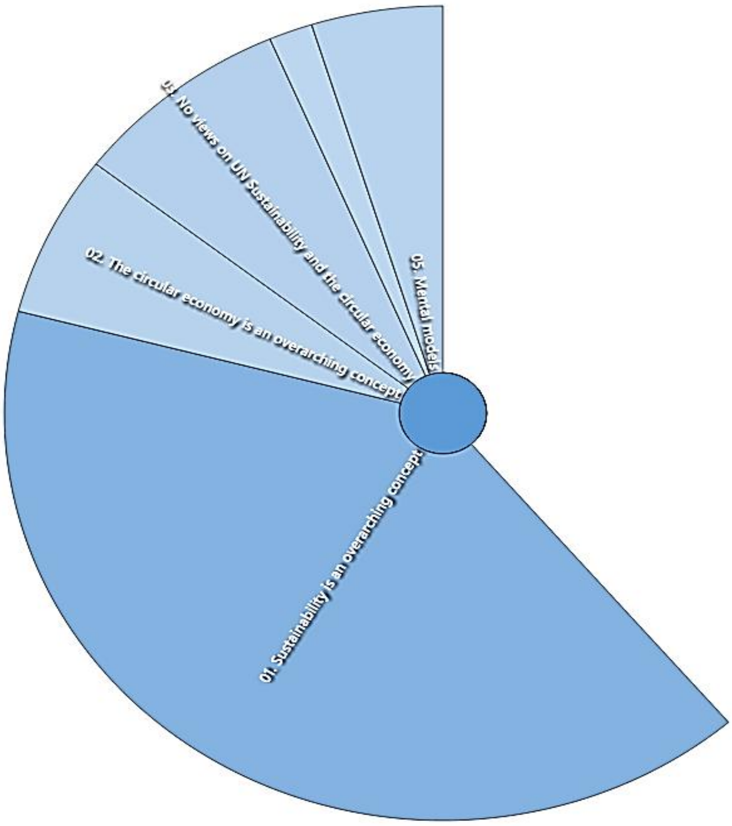

Figure 6-7: Comparing participants views about UN Sustainability and the circular economy

From table 6-13 and figure 6-7, we can say that about sixty-four per cent of the participants across all three sectors view UN Sustainability as an overarching concept, as compared to the circular economy. However, about twenty-six per cent of participants do not hold any views about sustainability and the circular economy, while only six per cent think that the circular economy is more encompassing than sustainability. In contrast, six per cent think that both sustainability and the circular economy are the same things. The details of coding references, aggregated number of items coded in this node is provided in Appendix 21_

Such confusions get amplified when the circular economy campaigners, instead of clarifying the differences, engage in promoting the circular economy through a variety of ways. As a result, it not only confuses the genuine patrons of the circular economy but also dilutes its importance, because most view the sustainability term with scepticism, synonymous to greenwashing, as identified by Borland et al. (2016 p. 300) and as the most used term (Pezzoli, 1997). The net result is a missed opportunity to save Earth and human beings across generations.

Across the three cases, about seventy-four per cent of participants consider a circular economy as evolution or natural progression, either from an environmental or waste management policy perspective, but not as a waste hierarchy. In contrast, only eighteen per cent of the participants consider the circular economy as a revolution.

Most participants adopt a technical approach to the circular economy and link it to the environmental or waste management policy, but not a waste hierarchy—it could be due to their academic background and job specification. Comparing and contrasting participants' backgrounds presented in Table 6-14 below revealed that about eighty-three per cent of participants have an engineering or science background and are involved in engineering-related functions in the firm. In contrast, only seventeen per cent have a business or economics background. While engineering and science are essential in evaluating and extracting the residual productive capacities of resources multiple times, it is also vital to balance the skill sets required to deal with the circular economy's business complexities, which are currently lacking. Therefore, we can conclude that there is an absence of equal representation of pure science and social science practitioners in advancing the circular economy's knowledge. Currently, pure science practitioners are handling commercial functions, which could be one reason for them not making a compelling business case and the slow uptake of the circular economy among UK businesses. Therefore, we find urgent calls for business model innovations across the two sectors to enhance resources' use-value. It is consistent with the circular economy literature calls for new business models (Chiappetta Jabbour et al., 2019). The Welsh Government has identified this as a skill gap and therefore decided to move the circular economy from its Natural Resources Department to the Economy Department.

Table 6-14: Comparing participants' academic and professional qualifications

Automotive Sector			IT Sector			Government Sector		
Sr. No.	**Participant**	**Background /Academic Qualifications**	**Sr. No.**	**Participant**	**Background /Academic Qualifications**	**Sr. No**	**Participant**	**Background / Academic Qualifications**
1	P1	Mechanical Engineer	12	P3	Commercial Background	20	P6	Bachelor's in environmental science
2	P2	Master's in environmental engineering	13	P9	BSC Environmental Science	21	P13	Masters in Oceanography
3	P4	BSc Engineering	14	P11	PhD in Environmental Engineering	22	P15	MBA
4	P5	Electronics Engineer	15	P14	Master's in environmental technology & Policy Specialisation	23	P16	PhD in Chemical Engineering -MBA
5	P8	Automotive Engineer Technician	16	P18	Product Management	24	P17	MSc in Integrated Environmental Management
6	P26	Commercial Manager	17	P33	HND in Electrical and Electronics Eng.& Masters in Sales management	25	P20	PhD in Child Language Psychology
7	P30	Metallurgy Engineer	18	P45	Bachelor's in industrial design	26	P21	Economics
8	P32	Chemical Engineer	19	P49	Business Development	27	P22	Statistician
9	P34	Master's In Design & Automotive Engineering				28	P24	MBA
10	P42	MBA				29	P27	BTEC Environmental Science Studies
11	P47 & P48	Undergraduates				30	P28	Economist
						31	P29	ICT and Project Management
						32	P36	Graduate in Waste Management
						33	P38	PhD in Mathematics & Certificate of Management Studies
						34	P40	PhD in Marine Geochemistry

Another point is that the way the circular economy has been in practice is shown in Tables 6-7; 6-8; 6 -9; 6-10, and 6-11. It reveals that there is utter silence about morality's role in the circular economy's practice, whereas, for sustainability, it is the opposite. Morality, in particular, is absent from the circular economy narrative. Gregson et al. (2015) have highlighted that despite the circular economy being promoted as an ideal way of keeping materials circulating within the economies, there is an absence of recognising the right and wrong ways of doing it. The logic of profit could be absenting the morality component in the case of a circular economy. If this is the case, then it raises curiosity about the reality of closed-loop recycling, which is the most popular way that a circular economy is implemented. It also exposes the contentious issues presented in Table 6-15 below and discussed briefly in the subsequent paragraphs.

- ***The contentious issues within a circular economy***

The combined impacts of Table 6-8 (comparing circular economy practices) and 6-12 (the logic of profit) is seen in Table 6-15 below, reflecting the contentious issues across three cases.

Table 6-15: Comparing contentious issues

Comparing the contentious issues		**Occurrences in cases**		
		Automotive	**IT**	**Government**
1	The Politics of the circular economy term	P1, P2	P11, P18, P49,	P6, P20, P21, P22, P38, P40
2	Vested interest influencing the circular economy	P1, P2, P32, P34, P42	P9, P33, P11, P14, P49	P6, P17, P36, P38
3	Economics oriented Cartel/ Competition Strategies	P2, P4, P5, P30	P3, P9, P11, P18, P49	P16
4	Dichotomy /Paradoxes	P1, P32	P11	P13, P15, P24
5	Wicked problems of circular economy	P1, P2, P4, P5, P8, P26, P32, P34, P42	P3, P9, P11, P14, P18, P33, P45, P49	P6, P13, P16, P17, P20, P21, P27, P28, P36
6	Gatekeeper issue	P1, P2, P32,P34	P33, P49	
7	European Commission politics of circular economy	P30		P28, P29, P38, P40

The politicisation of the circular economy term has also contributed to the confusion in its understanding. For instance, the ruling government prefers to use 'resource productivity' or 'resource efficiency' and consider the circular economy a confusing term. In contrast, the opposition prefers the circular economy term. About forty-six per cent of Government agencies participants choose resource productivity over the circular economy term. Gregson et al. (2015 p. 221) argue that 'forging circular economies within the EU entails challenges borne of a conjuncture of politically created markets'. It reiterates the author's argument that there is a heavy influence of politics in the circular economy's understanding and practice.

The confusion gets dense when the term 'improving resource's productivity' is achieved through digitalisation of factory processes or industry 4.0. It gives the impression that any improvement in resource use achieved through technological advancements, e.g., Artificial Intelligence, data mining, machine learning, simulation of factory processes, falls under the purview of a circular economy. The reality is that all these are tools to reduce waste, which is central to the waste hierarchy. Similarly, design inspired by nature (biomimicry) is linked to the circular economy.

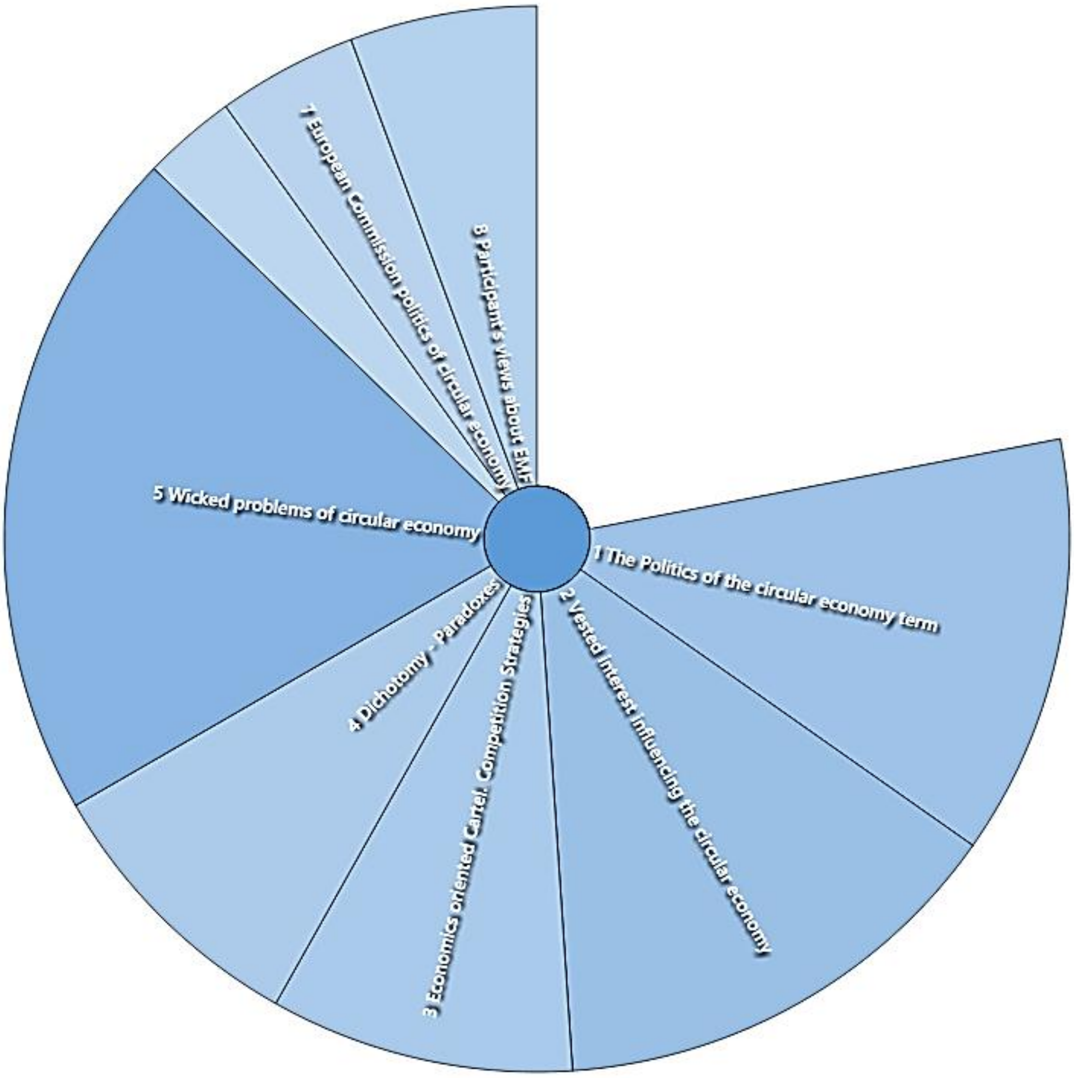

Figure 6-8: Contentious issues compared by numbers of items coded

Furthermore, in a bid to present a circular economy as an innovation-led concept and to drive recruitment of large companies and SMEs, the EMF conducts an 'annual disruption innovation festival' (EMF, 2017). It results in portraying circular economy rents in the light of Schumpeterian rents.

The presence of contentious issues further intensifies the misunderstandings of the circular economy. Some of these are as follows:

1. Being a member of the CE100 elite club also helps firms to brand their business as an ethical business (this goes without saying), which gives the perception that their business is aligned to, and can deliver, the UN Sustainable Development Goals, yet again confusing the understanding of the circular economy (P5, P36, P05).

2. They distort data to show extraordinary resources saving potential of the circular economy (P17).

3. They are often presenting a rosy picture of the circular economy by creating stories about the benefits of closed-loop recycling by MNCs (P32).

4. They collaborate with Big Four consulting firms to bring out publications/ reports on the circular economy, to be able to control the dissemination of knowledge about it. Thus, projecting themselves as thought leaders and making themselves an elite knowing the circular economy, projecting it as a case for paradigm change (Dietze, 2001).

An example is the making of the 'butterfly diagram' famous as a way to represent the circular economy – mentioned in almost all publications (e.g. EMF, 2012 p.24, 2013b p. 29, 2014 p. 14).

- ***The reality of closed-loop recycling***

Suppose the logic of profit is responsible for absenting the morality component and subsequently, the institutionalised absenting of environmental and societal dimensions from the circular economy narrative. In that case, it should get reflected in the practice of closed-loop recycling. With this logic in hindsight, the author revisited Table 6-8. It shows that sixty-four per cent of automotive sector participants and fifty per cent of participants from the IT sector confirmed that their firms practise the circular economy as closed-loop recycling. The same per cent of participants from both sectors have revealed that the main reason for their firms to operationalise closed-loop recycling is to protect their own interests. To protect self-interest, they form cartels which help them to hold ownership of the scarce resources for achieving competitive advantage. These firms also want to create credible stories of saving resources through influencing their supplier network, often under the guise of collaboration, while in practice, they do not reduce consumption and run their businesses as usual. This reality of the closed-loop recycling diminishes it to 'convenience-looped recycling'. Top MNC companies have made collaboration a way to integrate parts of the recycling process into their in-house value chain. About thirty-six per cent of participants from top automotive and twenty-five per cent of participants from IT MNCs have reported that their firm is following convenience-looped recycling instead of closed-loop recycling. As an example, firms 1 and 4 have collaborated to develop their convenience closed-loop recycling network because the origins of their parent companies are the same[49]. Therefore, the top management teams have similar cultural backgrounds within the collaborating companies. This practice was also found in other case companies, e.g. 12 and 13. Such convenience-looped recycling seems to be a common practice among MNCs, as Apple Inc. also practises similar acts under the pretext of the circular economy (Gregson et al., 2015; Laser and Stowell, 2017; Corvellec, 2018).

The closed-loop recycling is another form of a cartel. Nine per cent of the participants reported the presence of a cartel in the automotive sector. Cartels prohibit those firms who want to increase the recycled content in their products, because recycled content lets them lower their production costs, allowing them to pass the benefits to the customers by offering competitive prices, triggering fierce competition. As a result, the manufacturers create a cartel to influence trade associations, to block such a move by any manufacturer that is engaging in increasing recyclate materials in their production processes. Such cartels discreetly create doubts in customers' minds about the quality of products that are manufactured using recycled material.

The case firms that engage in convenience-closed-looped recycling are firms 1, 2, 4, 6 in the automotive sector, and firms 12, 13, 14, and 15 in the IT sector. The government agencies facilitate genuine collaboration, and examples are WRAPs programmes such as the Sustainable Clothing Action Plan SCAP2020, The Courtauld Commitment 2025, the UK Plastics Pact, and others.

The participating firms in the automotive and IT sectors use collaboration to achieve their convenience-closed-loop recycling network for achieving competitive advantage. Collaboration in strategic management is a dynamic capability that helps in achieving competitive advantage (Allred et al., 2011). It is underpinned by relationships that help to combine interfirm resources for achieving competitive advantage. Collaboration and relationships are features of an ambidextrous organisational culture (Wang and Rafiq, 2014), and both have been identified as dynamic capabilities (O'Reilly III and Tushman, 2008; Weeks, 2009). Collaboration and relationships are also central to supply chain operations (Dyer, 1997; Barratt, 2004 a; Gavronski et al., 2011; Agarwal et al., 2014). The creation of specific structures of relationships is central to capturing value in a collaborative ecosystem, suggests Jacobides et al. (2018).

Closed-loop recycling facilitates ownership control of resources, supporting the inimitability condition advanced by Barney (1991). Also, it is about resource orchestration, as the firm's managers engage in structuring synergies to bring back their used raw material resources and

[49] Firms 1 and 2 have been acquired by Indian multinationals. The names of these MNCs are withheld for confidentiality purposes following the Ethical Guidelines of Aston University.

then effectively bundle them so that their firm achieves sustained competitive advantage (Sirmon et al., 2011, September). Although resources orchestration is to a firm's advantage, usually it is seen with scepticism, because in reality, the reverse supply chain created to bring back a firm's used resources blocks third parties benefitting outside the chain. It is one of the consequences of such self-service reverse supply chains. The second is that it does not help reduce unemployment as a circular economy promises.

The above discussion indicates that closed-loop recycling can operationalise the concept of decoupling economic growth from the consumption of resources. However, it depends upon the intention of the top management teams how they are operationalising closed-loop recycling.

- ***The institutionalised absenting of the waste hierarchy***

The scarcity of resources, the competition, and the logic of profit leads firms to develop competitive strategies that require them to lobby Parliament for legislation that buttresses their business interests. All metrics for ascertaining recycling performance are weight-based. Even CO2 emissions measurements are in weights. The British Standards Institute created BS 8001 in 2017 to measure the circular economy performance index, which is also weight-based. A couple of participants said that the waste management companies are campaigning to make weight the index for measuring circular economy performance.

The lobbying by senior management of top waste management companies in the corridors of power, to pass waste-centric legislation, and their massive influence, might have triggered the institutionalised absenting of the waste hierarchy by the circular economy paradigm community. Also, a waste hierarchy is straightforward. It does not offer the flexibility to the senior management teams of MNCs to hide their commercial interests under the garb of collaborating for protecting the environment.

Waste management is a traditional, well-established capital-intensive industry with global networks and connections in places that matter. However, it has a highly ill-defined industry structure. Absenting wastes from the circular economy narrative would help the interests of non-waste management companies in the FTSE 100 and 500 rankings.

- ***Dichotomies and Paradoxes***

The European Commission is funding the promotion of the circular economy because it is aware that many people do not see the EU's worth, especially after the 2008 recession and Brexit. Under such circumstances, it finds the circular economy an excellent concept to embrace and for which to campaign. At the same time, it does not want to disturb the waste management lobby, hence clubbed both 4Rs in the circular economy. These kinds of interests result in further complicating the understanding of a circular economy.

The participants have reported that it is cheaper to manufacture products using virgin raw materials resource than recycled resources. In practice, the automotive and IT firms are keen to sell products manufactured from virgin resources, rather than recycled or remanufactured raw material resources as it works out cheaper, allowing margins and follow customers preferences. However, consumers' buying behaviour is slowly changing.

For recyclers, the content of recycling is essential, rather than the quantity of recycling, which is central to waste management businesses. There is a conflict of interests as the waste management companies are keen to increase recycling rates because weight and quantity of recyclate decide the price of wastes of any resource. Similarly, waste management companies are not interested in plastics because plastics are lightweight and do not enhance their waste recycling performances.

Another paradox is, the automotive sector rewards consumption so prefers to sell cars directly to consumers, using creative marketing campaigns supported by easy financing to attract more customers. The car manufacturers make more money selling spare parts rather than selling cars. Therefore, for them, selling remanufactured parts is not a lucrative business.

Recyclers and remanufacturers also face considerable challenges. Some of them are (a) acquiring a steady supply of end-of-life products or 'the core', (b) uncontaminated recyclate because of lack of proper infrastructure of the secondary raw material market -however, if waste-is-resource, then the term 'secondary market' comes under scrutiny, and it connotes a lower quality.

- ***The logic of profit and the circular economy***

Upon comparing the logic of profit, Table 6-12 shows that despite a majority of firms choosing to maximise revenues, a sizeable number of participants believe that well-being and environmental protection should be a part of the profit. It signifies the unexercised and unrealised powers of the circular economy. It is a typical modern-day representation of the 18-19th century economico-political debates on wealth accumulation and morality found in the historical roots of sustainable development - yet another reason for the conflation of UN Sustainability with the circular economy. The majority of participants who are of the view that a circular economy helps in maximising profits either belong to the CE100 club or are associated with the EMF in some way or other.

The maximising revenue logic of profit is the cause of the institutionalised absenting of the waste hierarchy. It has given rise to the practice of convenience-closed-loop recycling and the dichotomies and paradoxes discussed above. The practice has brought about the structural elaboration of the waste hierarchy, as the firms respond in various ways to the external shocks in a bid to increase their revenues, putting morality on the back burner.

The external shocks that the investigated firms face are from different directions, for example ,(a) high technologies such as industry 4.0 creating pressure to digitalise their traditional production processes, (b) the convergence of the IT and automotive industries, resulting in a blurring of the boundaries between the two sectors, and new non-conventional players entering the sector, (c) the constant need to look for substitutes to hedge various raw material resource price hikes and their supply risks, (d) geopolitical changes due to Brexit, (e) the COVID 19 pandemic that has completely altered the way business is conducted, (f) the ongoing impact of austerity measures resulting from the 2008 economic recession, and (g) the need to follow statutory legislative compliance.

These external shocks, along with the notion that wellbeing and conservation of natural raw material resources should be a part of profit maximisation, are the point of emergence of a new view of profit. It means there is an addition of 'value' in profit calculation, i.e. a profit will be of value only if that value is achieved by saving reserves of natural resources, and creating wellbeing for employees and future generations. This notion of profit resembles 'generation equity', which was discussed first in the 1987 Brundtland Report. Although it links the understanding of the circular economy to sustainability, it has never been actively pursued either by corporates or governments. A circular economy could be the best vehicle to achieve it, if there is an institutionalised drive to change the notion of profit.

The logic of profit underpins all debates and discussion in strategic management for achieving sustained competitive advantage. A profit achieved through dominance is central to the theory of competitive advantage. The competitive advantage theories such as the resource-based view buttress the idea of resource acquisition, accumulation, and allocation for achieving competitive advantage (Wernerfelt, 1984; Barney, 1991; Barney and Clark, 2007; Makadok, 2011, September; Wernerfelt, 2011, September). Whereas the dynamic capabilities theory, which is an extension of RBV, argues that the joint presence of dynamic capabilities, VRIN resources, and a good strategy would help to achieve competitive advantage. (Teece et al., 1997; Teece, 2007, 2014b, 2019a). Thus far, not a single competitive advantage theory has attempted to change the meaning of profit, because possibly it does not suit the democratic capitalist approach[50] reflected

[50] The author has used this word in its everyday sense, and it is not about the Theory of Capitalism.

in the findings, i.e. reluctance of the participants to discuss their views about the notion of profit openly.

According to Rumelt (2003), the competitive advantage is about value creation and capture, but there is no agreement on value for whom and when. Similarly, there is no agreement about how value is conceptualised and measured. Rumelt (2003) also mentions that the problem is not with the idea of competitive advantage but with the concept of cost and profit (that a firm chooses to follow). In neoclassical economics, profit is a chimera. The conjectured reality of value presented by Pitelis (2009)offers a detailed account of how conjectured value is conceptualised, exercised, and actualised, using Penrose and Schumpeter's protagonist, the entrepreneur, and the image in his/ her mind (Schumpeter, 1934; Penrose, 1959). If all these pieces are put together in the context of the circular economy, then cost and profit are in the minds of the corporate bosses who can be driven by a sincere and genuine desire to lower consumption and create 'morally responsible profit.' Table 6.10 shows that about forty-four per cent of participants from across the three sectors have voiced their concern about creating a 'morally responsible profit,' to address the challenges across the two neglected dimensions, i.e. environmental, and societal benefits.

In a 'morally responsible profit' calculation, the value is achieved through full cost accounting. It means internalising all operating costs, including the damage done to the environment, and externalising rewards. Such a conceptualisation of value will impact the logic of profit, which would impact the current view of competitive advantage. A circular economy with moral values embedded in its logic of profit has the unexercised, unactualized power to bring about a paradigm shift. This thinking has profound implications on society because 'how we make things' dictates not only how we work' but 'what we buy, 'how we think', and the 'way we live'(Womack et al., 1990). The recent COVID 19 pandemics has already changed how we live, buy and do business and demonstrate new ways to address environmental issues leading to a competitive advantage based upon morally responsible profit. In this regard, the circular economy is a paradigm that can bring about a paradigm shift by lowering consumption, yet achieving economic growth. In other words, the circular economy has the unexercised and unactualized power to separate economic growth from resource consumption. Thus, making it a reality that is yet to happen.

From the point of view of this research, the logic of profit embedded with the value for wellbeing for all individuals and species, and their future generations, would impact on the way firms acquire, use and manage their resources. As a result, existing theories of competitive advantage, especially the resource-based view and dynamic capabilities, would need revisiting. (Wernerfelt, 1984; Barney, 1991; Amit and Schoemaker, 1993; Teece et al., 1997; Makadok, 2001b; Makadok and Barney, 2001; Teece, 2007, 2014b, 2019a).

6.5.2 The emergent characteristics of a circular economy

From the findings, analysis, and discussions, it has become evident that the reality of the circular economy is an augmented waste hierarchy. It means the waste hierarchy has undergone structural elaboration, caused by the simultaneous play of different mechanisms, already discussed above. Furthermore, Chapter 4 informs us that the circular economy is a transitive entity. Consequently, the reality of a circular economy must possess characteristics that make its existence identifiable, similar to any intransitive entities; for instance, we know about water by its physical and chemical properties, or by its wetness properties. Similarly, characteristics that help us to know about the reality of a circular economy are practiced across the empirical, the actual, and the real domain, in a manufacturing environment and are as follows.

A. The properties of a genuine circular economy exhibited in the real domain

A firm's reality of circular economy practice is knowable, if it has the following features at its core:

1. The presence of subtractive manufacturing and the generation of waste and scrap.[51]

2. There is a genuine intent and the required organisational capabilities to extract the residual productive capacities from waste and scrap.

3. There is a genuine intention to reduce the consumption of virgin raw material resources. That is if the intention is correct, then the action flowing from it would help to reduce the theory-practice contradictions explained earlier. Accordingly, the firm would take proactive actions to define the path, processes, and positions for reducing consumption of virgin raw material resources.

4. Maximising revenue is done through 'morally responsible profit'. Morally responsible profit is about creating economic surpluses by engaging in ethical practices, while being aware of the economic disparity that exists within the society.
5. The belief that local commercial activity has a global impact. Therefore, a firm's local commercial activity is a high priority area to be checked up on.
6. There is a meaningful change in the existing way of doing things, towards lower consumption.

[51] Scrap materials have all their productive abilities intact.

7. The path, processes, and position that a firm adopts are liberating. That is, they free human beings from any kind of bondage.
8. The circular economy can alleviate poverty.

B. The properties of a genuine circular economy exhibited in the actual domain

A genuinely practised circular economy is strategic and dynamic by nature. The intent that drives its path, processes, and positions are:

1. Always on the look-out for a substitute for those virgin raw material resources that are currently in use.
2. Generates socially profitable innovation, observed and experienced either in one or more ways, such as:
   a. Radical innovation to completely change the existing way of doing things to protect the environment and create social benefits.
   b. It pursues incremental or radical innovation in its production processes.
   c. It supports proprietary technology development.
3. The firms should possess the managerial capabilities required for understanding the extractable potentials of waste/scrap.
4. The managers should be able to ascertain the future demands of extracted raw material resources.
5. Performance focused, i.e. promotes access to products and services rather than ownership and consumption of the products.
6. Consolidation of the supply chain, not for ownership of scarce raw material resources but for preventing contamination of recyclate.
7. Enables cross-sectoral collaboration for reducing consumption and achieving morally responsible profit.
8. Supports proprietary technology development for generating morally responsible profit.
9. Allows the multi-side markets to operate synchronically.

C. The properties of a standard circular economy exhibited in the actual domain

1. The firms that are practising recycling are either in one or more forms of the 4Rs.

2. Follows end-of-life strategies.

3. The institutional capability in terms of plant and machinery, process, procedures, and routines for reducing consumption.

4. The firms collaborate across their supply chain to keep resource ownership and further their resource positional advantage. So they design their supply chain in such a way that they get their scrap back. Alternatively, they recover it from their end-of-life products.

5. The firms develop proprietary technology for competitive advantage in their niche markets and brand themselves as an ethically driven ‘circular economy company’. The logic of profit is wealth accumulation for the firm.

6. They form cartels for keeping control over the raw material resources price.

7. Traceability: A new emerging property, specific to the circular economy, is traceability of material. Ability to trace the material plays a crucial role in managing recyclability effectively, i.e. ability to trace the material right from its conception stage to its successive cascading by different agents to realise its full value. This information will be helpful for accounting and finance functions, to address ownership issues. It allows a connection between those who produce and consume them, opening up another dimension of communication for more effective collaboration between different agents and agencies.

8. Flexibility is one of the critical drivers of the circular economy, both at the level of manufacturing processes and material chemistry. At an organisational level too, flexibility helps to reconfigure the structure of the firm in order to exploit a real market opportunity.

Thus, from the above, we see that the idea that there are two types of circular economy has emerged without our realising it. One is (a) a Standard Circular Economy or the regular circular economy; whereas, the other is (b) the genuine circular economy or the Advanced Circular Economy. The line of demarcation between the two types of the circular economy is slim, and the circular economy campaigners often take advantage of this to promote the former rather than the latter.

Besides the properties described above, few properties appear in both types of the circular economy. The intention with which an activity is performed differentiates the genuine circular economy or the Advanced Circular Economy, from a Standard Circular Economy or the regular circular economy.

- ***Innovation as seen in the empirical domain of the circular economy***

Almost all automotive and IT firms participants inform that their firms carry out innovation in various forms to reduce their production cost and hedge high raw material resources price volatility. The firms use a combination of used and virgin resources to extend the value of raw material resources extracted from end-of-life products. At times, this involves altering the chemical and physical properties of materials to address customers' needs, while reducing the consumption of virgin resources. On occasions, this has resulted in creatively disrupting the existing market - examples are fims;16 (P3), 9 (P26), and 3 (P42) (Schumpeter, 1934). When such creative disruptions are made for securing future cash flows alone, then such activities fall under the standard circular economy. However, if the campaigners promote it as the genuine circular economy or the Advanced Circular Economy, then it becomes problematic as it fails to cover the environmental and societal dimensions.

The dynamic capabilities framework has several antecedents, of which Schumpeter's is one (Teece et al., 1997 p. 515; Teece, 2019, May). Teece's (1997) assertions lead us to categorise the capabilities of P3, P26, and P42, as dynamic capabilities as they help to achieve creative market disruptions in their niche markets.

In order for a firm to have a steady pipeline of innovative products that disrupt markets, it has to be an ambidextrous organization (O'Reilly III and Tushman, 2004, 2008; Teece, 2014b p. 337). It means that a firm should be able to separate their exploratory and traditional units. The exploratory units should focus on developing new processes, cultures, and structures without disturbing the traditional units that earn bread and butter for the firm. Thus, it will enable a smooth transition from business-as-usual to the genuine circular economy or the Advanced Circular Economy business. In the absence of such a process, transitioning to the genuine circular economy business becomes more complex and cumbersome.

Therefore, not all innovations that are creating market disruptions are an accurate representation of the genuine circular economy or the Advanced Circular Economy.

- ***Collaboration as practised in the empirical domain of the circular economy***

Reduced consumption is achievable in several ways. One is to collaborate to share resources. Operationally, it boils down to recycling, where the waste of one could be remanufactured and recycled for another user. Relationships are central to achieving collaborative consumption. Both Barnes and Mattsson (2016) and Wang and Rafiq (2014) have found a relationship between ambidextrous organisational culture, contextual ambidexterity, and product innovation. Jacobides (2018), in his theory of ecosystems, argues that structures of relationships are central to capturing value in an ecosystem. We already know that collaboration is central to supply-chain operations and fostering manufacturing in regions because better collaboration between government and industry has been crucial in developing the regions, industry, and enhancing innovation (Amison and Bailey, 2014; Bailey et al., 2019a).

However, while discussing the reality of closed-loop recycling in the above paragraphs, we witnessed Case companies collaborating for creating convenience-closed-loop recycling for commercial gains. Therefore, from this, we gather that, not all collaborations are for establishing a genuine circular economy or the Advanced Circular Economy.

- ***Incremental improvement and the circular economy***

Compliance to legislation to reduce emissions, lowering GHG, improving recycling targets, statutory indicators, and many more EU directives aimed at reducing resource use, have led automotive manufacturers, metal and polymer recyclers, and remanufacturers to develop incremental improvements. These incremental improvements are usually signature processes, which are distinctive and proprietary, and help businesses to differentiate themselves in their niche markets. Such signature processes are defined as micro-foundations of dynamic capabilities by Teece (2007, 2014a).

However, there are pieces of evidence from the automotive sector’s recyclers and remanufacturers that they develop signature processes to gain a competitive edge and not for saving virgin raw material resources or creating societal benefits. Therefore, such remanufacturers and recyclers follow a standard circular economy.

Also, not all incremental innovations or signature processes are an accurate representation of the genuine circular economy or the Advanced Circular Economy.

6.5.3 Conclusion of Discussions 1 and next steps

The Sub-sections from 6.2 to 6.4 helps us to answer research questions one and two.

It is clear from the evidence that businesses adopt the circular economy as relevant to their business needs. All the evidence establishes that a circular economy is not a new concept. Several traditional activities have been rebranded as a circular economy. Primarily, at a high-level, businesses understand the circular economy as recycling. However, it is not as straight forward as it sounds.

As a result of the adoption, the circular economy often gets conflated with either the UN Sustainability programme or, other concepts. It is conflated with UN Sustainability because both work across the economic, environmental, and social dimensions.

These concepts vary from the 4Rs activities to closed-loop recycling to design thinking to technical innovation-led servitization models, to lean management and energy conservation. There is a conspicuous absence of the waste hierarchy term in participants' responses, although all of the activities carried out are a part of the waste hierarchy. In reality, a circular economy is the augmented waste hierarchy. Several mechanisms are playing underneath, causing this deliberate institutionalised absenting of a waste hierarchy. As a result, it gives rise to several paradoxes and dichotomies, which in reality are harmful to the environment and society.

The reality of closed-loop recycling is to buttress the need for profit maximisation of the corporates, and not for environmental protection or to deliver societal benefits. Almost all Case companies follow the logic of profit maximisation. However, it is evident from participants' responses that there is clear scope for including environmental and human wellbeing in the actual profit calculations, thereby recalibrating accounting principles[52].

There is a heavy influence of the latest technology developments on the waste hierarchy which has led to its structural elaboration, assigning powers to it, making it possible to decouple revenue growth from the consumption of raw material resources. From the structural elaboration, the properties of a circular economy, across the three domains of reality, has emerged, identifying two different types of the circular economy. These properties also help to show any theory-practice contradictions, that is, it helps to identify if a firm follows a standard circular economy, or an Advanced Circular Economy, or the genuine circular economy.

It is interesting to find that in both sectors, most of the top MNC firms (e.g., firms 1, 2, 4, 6, 8, 12, 13, 14, 15, 17, and 18) having advanced high technology, practise a Standard Circular

[52] Addresses the curiosity raised in footnote note no. 7.

Economy. Whereas SMEs (e.g., firms 3, 5, 7, 9, 10, and 16) practice an Advanced Circular Economy.

The next Sub-section, 6.6 discusses a genuine circular economy's theoretical impact on a firm's resources and capabilities and, in turn, on the concept of competitive advantage.

6.6 Discussion 2: About the impact of understanding of the circular economy on firms' resources and capabilities.

Now that we know that the reality of a circular economy is an augmented waste hierarchy, it becomes essential to test the applicability of VRIN characteristics in this new context, because VRIN resources are a part of the conceptual framework for this research (*c.f.* figure 3-2). Another reason for testing is the emergence of a circular economy as the micro-foundation of a dynamic capability (Teece, 2014b p. 334, 2019a p.11; Khan et al., 2020).

In the VRIN framework, the valuable and inimitable characteristics of resources are central for assigning meaning to the framework, despite rarity and non-substitutability characteristics being necessary conditions (Hoopes et al., 2003; Hoopes and Madsen, 2008). The debates on 'value as a meta-text in RBV' help us to understand that, between valuable and inimitable characteristics, inimitability is dependent upon value. Because, if there were no valuable resources, the need for imitating ceases to exist. As a result, knowing how resources create value and how value is captured becomes vital, especially when a firm intends to sell outcomes instead of products or services, (Feiler and Teece, 2014; Sjödin et al., 2020) for decoupling revenue growth from the consumption of resources.

From a purely economic sense, value creation happens when a consumer is willing to pay more for (a) some novel benefit(s) that they perceive to be getting from a product. (b) Alternatively, for something that they perceive better than a previous product, or (c) when they perceive that they will receive an earlier benefit at a lower unit cost. Thus for a consumer, value creation means an increase in use-value or a decrease in the exchange value (Priem, 2007). We also know that the determinants of value creation are innovation, virtual markets, strategic networks, managerial capabilities, and cognition (Gavetti, 2005; Pitelis, 2009).

Value capture is the process of securing profits from value creation and the distribution of profits among participating actors such as value creators, customers, and partners. Consequently, value capture happens when a firm receives (a) consumer payment by defeating a competitor's attempt to imitate, and (b) simultaneously retains such payments by denying the claims on them from upstream or downstream members of the same value system. Priem (2007); (Chesbrough et al., 2018; Dyer et al., 2018).

The author re-reviewed the main order themes to find how the automotive and IT firms create value from their used resources. Finding how firms capture the value thus created is beyond the scope of this research because it requires an entirely different set of calibrations for measuring the value captured. However, the Tables 6-16 and 6-17 tracks the process of value creation in the automotive and IT sectors.

Table 6-16: The process of value creation within Automotive firms

Investigated Firms/ Participants	Primary value creator	The process of value creation is by following the waste hierarchy					Process of value creation: Flexibility		Process of value creation: Technological advancement	
		Reusability/Reparability Reduce	**Reprocessing Ability**	**Recyclability**	**Remanufacturing Ability**	**Recoverability**	**Innovate capacity to delink/ combine through chemical**	**As a substitute**	**The intelligent design of material or product for disassembly**	**Product as service or servitization model**
Firm 1/ P01	Offsets prime metal (Aluminium). Helps in value-creating strategy (P1).	Part of the process.	Does not change chemical properties while reprocessing.	Recycling a norm. Inherent characteristics to recycle multiple times.	Do not do directly.	Scrap recycled to recover valued material.	Aluminium alloy is critical to reducing vehicle weight.	Aluminium alloy is a substitute for prime metal, which is energy-intensive.	Design central to reduce the weight of the vehicle and offset prime metals.	Not applicable.
Firm 2/P34	Offsets prime metal (Polypropylene and Polyamide). Helps in value-creating strategy (P34).	Part of the process.	Followed	Recycling is a norm.	Do not do directly.	Part of the process.	Polypropylene to reduce cost.	Polypropylene offsets metal alloys.	Design central to deciding about materials their functionality and availability.	Not applicable.
Firm 3/ P42	Saves prime virgin material - heavy use of new material composites carbon fibre (P42).	Not produced at the moment as a business is in the early stages of going to market.			Possible	Not yet researched.	Not applicable.	Use Hydrogen fuel cell and alternative to fossil fuel.	Design on three levels – product at systems level and ideology (governance).	A business model based on product as service and retained ownership of the resources.
Firm 4 /P02	Saves and conserves Prime virgin material (P2).	Not applicable.	Reprocessing by cleaning.	Recycling the mainline of business through a complicated process.	Recycling through the complex process also fills in remanufacturing domain.	Recover aluminium from its scrap after following a complex process.	Combining metals to make an aluminium alloy that can replace prime aluminium and reduce vehicle weight while making it fuel-efficient.		Aluminium alloy or polymer composites challenging to separate.	Not applicable.
Firm5 / P47+48	Conserves prime virgin material (P47+P48).	Cleaning and reusing the material in some other application.	Reprocessing by cleaning.	Recycling the mainline of business.	Not applicable.	Part of the process- mostly physical through use of eddy currents.	Not applicable.		Not applicable.	Not applicable.
Firm 6 / P32	Conserves virgin polymer production (P32).	Not applicable.	The not applicable Cleaning part of reprocessing.	Recycling is a norm.	Remanufacturing part of the recycling.	Recover core from scrap.	Altering chemical structures of polymers as per the application and substituting the newly designed material from previous scarce environmental hazardous materials.		Technical knowledge is the primary driver to improve the quality of recyclable products.	Not applicable.
Firm 7/P05	Conserves resource – Waste for car owner OEM is valuable for remanufacturer (P5).	Reuse is part of the process, reuses packaging material.	Part of the process.	Recycling is a norm.	Mainline of business.	Recoverability is a part of the process.	Not applicable.	Remanufactured ECU and PCB boards are substitutes.	Not applicable.	Not applicable.
Firm 8/ P08	Conserves resource – waste for care owner OEM is valuable for remanufacturer (P8).	Reuse is part of the process.	Reprocessing is a part of the process.	Recycling is a norm.	Mainline of business.	Part of the process.	Not applicable.	Remanufactured engines gearboxes, starter, alternators, air conditioning pumps, Differentials, Drive Staffs, Axels are substitute.	Not applicable.	Not applicable.
Firm 9/ P26	Stock used energy repurposing (P26).	Reuse the mainline of business.	Not applicable.	All battery parts can be recycled.	Not applicable.	Not applicable.	Alternating chemical structures of phase change materials.	Substitute to Lithium-Ion batteries.	The design of the battery is for disassembly and fully recyclable.	Not applicable.
Firm 10/ P30	Advice and design use of substitute material for conserving and saving prime virgin material (P30).								Design as the primary drive.	Not applicable.
Firm 11/ P04	Use of Lean management tools and techniques to reduce waste, which leads to conserving resources through recycling, repair, reuse, reprocessing, recovering and remanufacturing (P4).								Not applicable.	Not applicable.

Table 6-17: The process of value creation within IT firms

Investigated Firms/ Participants	Primary value creator	The process of value creation is by following the waste hierarchy					The process of creating value Flexibility		Process of creating Technological value advancement	
		Reusability/ Reparability	**Ability to Remanufacture**	**Recyclability**	**Product as service or servitization model**	**Design Value**	**Innate capacity to delink/combine through chemical**	**As a substitute**	**Recoverability**	**Time compression**
Firm 12/ P11	Saves prime virgin material.	Extending the product's lives through service and repair.	Some parts of pointers are remanufacturing using post-consumer polypropylene.	Recycling as part of service. Printer cartridges recycled Recycling through dematerialisation	Offers Ink as service	Design for repair and reuse.	Altering the chemical structure of the material.	Altered material used as a substitute.	No material recovery operations other than PET plastic bottles.	None reported.
Firm 13 /P49	Saves prime virgin material.	Extending the product's lives through service and repair.	None reported.	Recycling as part of service Printer cartridges recycled Recycling through dematerialisation	No servitization model reported	Design for repair and reuse.	Creating solutions uniquely. Design smarter products that can are multi-purpose used multiple times.	Recovery as substitute.	Material recovery for remanufacturing. E.g. Gold recovered from PCBs.	None Reported.
Firm 14 /P14	Conserves resources other than prime virgin materials, reduce energy usage.	Reusability through repair. Redistributing old equipment to be redeployed in other markets.	Partial manufacturing by using old equipment.	Recycling is part of resource conservation activity	None reported	Not exactly reported.	None reported.	Product's reuse or remnants of the materials repurposed elsewhere.	No material recovery operations reported.	None reported.
Firm 15 /P18	Conserves resources other than prime virgin materials.	Reparability/ Reusability.	Partial manufacturing by using old equipment.	Recycling and rethinking accounting principles.	Offers Cloud Services using renewable energy.	None reported.	None reported.	None reported.	Material recovery for partial manufacturing.	None reported.
Firm 16/ P3	Creative destruction enabled through resource and technological advancement.	None reported.	3D enables manufacturability.	Not significant.	3D manufacturing Additive manufacturing.	The design enabled through digitalisation.	Chemical composition altered.	Resource's ability to allow altering its chemical structures.	None reported.	3D additive manufacturing reduces the time required to manufacture parts thereby reducing the time to market
Firm 17/ P33	Offsets as well as conserve prime virgin materials.	Productive analytics using data-producing maintenance through automation enabled by IoT and IIoT. Leads to a servitization model.	Digitalisation and digitisation allow manufacturability.	The digitalisation of products allows recyclability.	Servitization model Productive maintenance enhanced uptime guarantees.	The design enabled through digitalisation.	None reported.	Servitization model. Productive maintenance enhanced uptime guarantees.	Productive analytics using data producing maintenance through automation enabled by IoT and IIoT Leads to a servitization model.	Time compression possible.
Firm 18 /P45	Serves prime virgin material through design.	Design for durability, getting the product back to support repair and remanufacturing.	Design for durability, getting the product back to support repair and remanufacturing.	Design for recyclability.	Design for servitization possible.	Design is central to all activities.	Creating solutions in a unique way to design smarter products that are multi-purpose, and used multiple times	Possibility of designing a substitute material.	Design for disassembly and recovery.	Time compression possible.
Firm 19/ P9	Eliminates wastages in processes.	Lean management allows repair, reuse.	Lean management allows repair, reuse.	The economic value derived from recycling.	No servitization model reported.	None reported.	None reported.	None reported.	None reported.	Time compression possible

6.6.1 VRIN factors: Studying the relevance of 'Valuable' characteristics in the circular economy context

The Tables 6-16 and 6-17 above demonstrate that the IT firms are more advanced as compared to the automotive firms in conserving prime virgin materials, and are disrupting markets, primarily through technological innovation. Most automotive firms engage in incremental improvements using technology, except one (firm 3), which is disrupting the automotive sector's landscape.

Recycling has emerged as the most preferred activity in both automotive and IT firms. Following recycling, most firms investigated endeavour to find substitutes for the scarce raw material resources they consume. In case a substitute is not available, they look for achieving material circularity through a variety of ways, and nine times out of ten, they choose closed-loop recycling.

In general, it is possible to group value creation across automotive and IT firms under three headings, i.e. the value creation happens (a) through recycling, (b) through high-tech, and (c) through innovation and automation.

In both sectors, the value is created through a variety of ways such as by,

(a) completely offsetting prime virgin materials or, by

(b) reducing the quantity of virgin material used by combining used material with virgin material, or by

(c) conserving all resources other than prime virgin materials (d) reducing energy usage, or by

(d) storing wasted energy or, by

(e) eliminating wastages in processes, and

(f) using technology that creatively alters the current ways of doing things.

In addition to the above, the value is created (a) by offering products-as-service, or (b) designing raw material resources to replace virgin material - most IT firms engage in these activities.

The value creation through recycling is dependent upon two factors; (a) the inherent productive reuse capacity of the raw materials resources, and (b), the cognitive, technical skills and capabilities of the manager (to sense the functionality and reuse potential of a resource), and the firm's infrastructure capability to extract the residual productive capacities from such raw material resources by combining waste and virgin resources in different permutations and combinations. Strategically, it means two things, that is,

(a) It gives rise to complementary assets discussed in greater detail in strategic management literature for creating value and profiting from innovation, and also in the context of technology-enabled business ecosystems, (Pitelis, 2009; Gawer, 2014; Chesbrough et al., 2018; Teece, 2018a, b). Bocken et al. (2017bpp 480) identify asset complementarity as furthering the cause of circular economy. Dyer et al. (2018) has talked about value creation when firms having complementary resources have an alliance. The discussions also lead to co-specialization and co-specialized assets, as they are the building blocks of firms, according to Teece (2017b p.708), for achieving competitive advantage. It is also considered critical for achieving sustainable development (Mousavi et al., 2018). According to Lippman and Rumelt (2003 p. 908) the increment in value through co-specialized resources is not reflected in raw material resources prices in strategic factor markets (Barney, 1986). They also believe that the firm-specific 'resources' or 'rents' or 'profits' are a mistake, as RBV assigns payments to the resources alone. All the above assertions by different scholars signify that recycling is strategic, requiring dynamic capabilities for its realisation.

(b) In the context of the newfound reality of a circular economy, waste is the new resource. Alternatively, end-of-life products have become primary resources. In such an eventuality, the applicability of Barney's VRIN factors (1991 pp. 105, 106) for achieving a competitive advantage needs revisiting.

The VRIN factors stipulate that a resource should possess four characteristics for it to help a firm achieve a sustained competitive advantage. That is, (a) 'it must be valuable, in the sense that it exploits opportunities, and/ or neutralizes threats in a firm's environment, (b) it must be rare among a firm's current and potential competition, (c) it must be imperfectly imitable, and (d) there cannot be a strategically equivalent substitute for the resource that valuable but neither rare nor imperfectly imitable.' (Barney, 1991 pp. 105,106)

It means a recyclable raw material resource would be valuable only if it helps the firm to either neutralise threats and exploit opportunities. From this perspective, a valuable recyclable resource for manufacturing firms is that which is easily recyclable. Therefore, raw material resources such as aluminium (for investigated firms 1, 4, and 10); Polypropylene (for firms 2, 3, 6, 7, 12, 13), Polybutylene terephthalate (for firms 16, & 17), and other raw materials used by investigating firms are easily recyclable. Hence, they are valuable. These materials also help the firms to implement strategies to compete in their respective niche markets. Therefore, such easily recyclable resources are consistent with the 'valuable' condition of the VRIN framework.

However, this does not mean that all easily recyclable raw material resources would be valuable because the market forces decide the prices of such resources. That is, if a bale of a particular resource is more in weight, then the selling price of an element from that lot will be lower-priced in the secondary materials market. The secondary materials market represents Barney's conceptualisation of strategic factor markets (Barney, 1986; Barney and Mackey, 2016). Under such circumstances, the firm would not be able to implement its cost-cutting strategies, and in turn, would not be able to generate a competitive advantage for itself. Thus, although a raw material resource is easily recyclable, it will no longer be valuable. Hence, it will not generate a competitive advantage but 'a competitive parity'(Barney, 1997 p. 19). These ground realities raise concerns regarding the Government's policy of creating a secondary materials market to accelerate the transition to a circular economy (firms 20, 21, 24, and 27 –P20, P22, P06, and P36 respectively).

Such ground realities would undermine the 'circular advantage,' emanating from circular supplies, suggested by Accenture (2014 p. 12), as secondary materials markets would not be able to offer stable prices for the easily recyclable raw material resources. However, there are chances that a convenience-closed-loop supply chain would be able to offer a circular advantage. Still, there is a likelihood of omitting the environmental and social dimensions by such convenience-closed-loop supply chains. Similarly, it also questions other closed-loop supply chains' utility in other frameworks, such as 'L-Loop' in the 'ReSOLVE framework' (EMF, 2015b p. 26).

Tables 6-16 and 6-17, show that Case companies predominantly use technology to create value. Designing raw material resources that support easy recycling has emerged as the most preferred way of creating value. However, most companies have approached the design facet from different perspectives, as relevant to their business. For example (a) for lowering consumption of prime metals through designing alloys that not only reduce the overall weight of their product, but also facilitate easy recycling, (b) for easy recoverability. and (c) for easy disassembly, to name but a few.

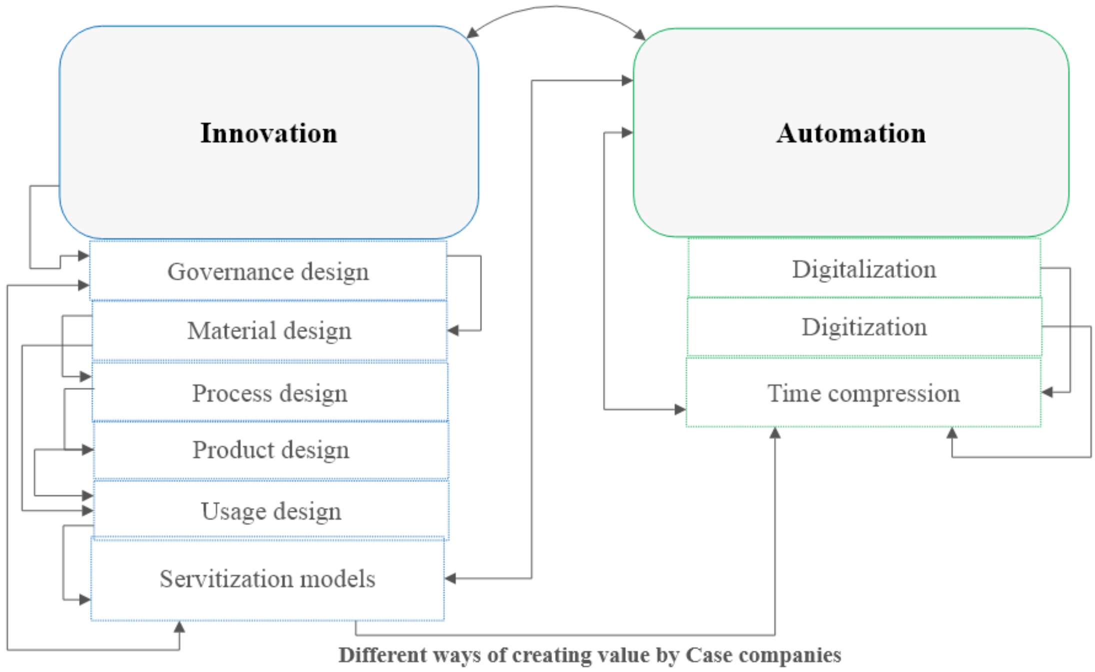

Figure 6-9: Different ways of value creation distilled from Tables 6-16 and 6-17. Source: Author (2020)

Figure 6-9 above, distilled from Tables 6-16, and 6-17, shows that innovation and automation are the second most preferred ways of creating value by automotive and IT firms. Digitalisation is an enabler for both innovation and automation.

Most automotive and IT firms engage in incremental innovation. However, the governance of design is absent in both sectors, except firms 3 and 18. That is, there is a complete absence of any principles or guidelines that govern the designing of processes or products to extract the residual value from the recyclate. It means that the method adopted could be an energy-intensive activity, or the effluents could be toxic, harming the environment. It could also mean that the method adopted could benefit only a small group of people or corporates.

Material design, product design, usage design, and servitization models are interlinked. They play a vital role in extracting value from the recyclate and conserving virgin raw material resources. The processes are usually business-specific and help a firm to compete, resembling 'the signature processes', which Teece (2014b p. 333 2019a p. 23) has described as being a part of the dynamic capabilities owned by a firm. Such signature processes, if patented, cannot be copied easily by competition, argues Teece (1988 p. 53). Further, Teece (2018b p. 1368), argues that patented signature processes are a bit different from other regular patents that provide little protection from a breach, because in many countries law enforcement for intellectual property is weak or non-existent, which is detrimental for appropriating returns from innovation.

Automation underpins digitalisation and digitisation. It has further opened a wide range of opportunities for creating value. They help in constituting an inclusive society that lowers consumption, improves the environment, and facilitates wellbeing for all. Automation supported by digitalisation is also central to decoupling revenue growth from the consumption of raw material resources.

Industry 4.0, 5G Wireless technology enabling robust Cloud Services, and Artificial Intelligence leads to automating the business processes (firms 1, 2, 3, 9, 10,12, 13,16 17, and 18), and forms the backbone of a digital economy. Yet another reason for equating the circular economy with a digital economy. These technologies are essentially enabling technologies, which Teece (2018b) has categorised as ‘General Purpose Technologies’, similar to earlier technologies such as the Electricity Grid, Steam Engines - machines that changed the world (Womack et al., 1990).

Strategically, these enabling technologies support modularisation, bringing the design thinking to the forefront, resulting in new business ecosystems. A group of platforms makes a business ecosystem, centred around platform architecture driven by engineering design, also known as economic ecosystems. These are the new market structures where competition is between ecosystems. Within each ecosystem, there are several players. It allows modularity, coordination, complementarities, co-opetition, collaboration, standardization, and regulation of processes that are easy to handle (Schischke et al., 2016; Jacobides et al., 2018; Teece, 2018a, b; Sedláček, 2019). Such types of market architectures give rise to multi-sided markets, which are incredibly supportive for creating value through 4R process, and for forming an open-loop system for reverse logistics (Gawer, 2014 pp 1239-1240).

Table 6-18: Emergence of multi-sided markets enabled by technology platforms Source (5GAA, 2016, November)

Markets	Players
Business to Business B2B	• Carmakers monetize application providers for user Experience services to passengers. • Communication Service Providers monetize the use of the Cloud by carmakers. • Mobile Network Operators monetize the use of the network by application providers and over the Air service providers.
Business to Customer B2C	• Car markets monetize personalized services to passengers. • Mobile Network Operators monetize car makers for driving assistant and passengers' experience.
Business to Business to Customer B2B2C	• Mobile Network Operators monetize the network infrastructure for computation/ storage by application providers, e.g. HD maps, Virtual reality applications. • Application providers monetize car makers for the provision of applications. • Carmakers monetize users (passengers, drivers of non-fully autonomous vehicles).
Consumer to Consumer C2C	• Passengers (and drivers in non-fully autonomous vehicles) share road hazards information with vehicles in non-line of sight in a mutual way.

Table 6-18 above explains how monetization would happen in the automotive sector, that would turn into a multi-sided market, as a circular car enabled by 5G and V2X technology (Virtual to Everything technology) becomes a reality. V2X has immense communication capabilities, i.e. it can communicate between vehicle-to-pedestrian, vehicle-to-vehicle, vehicle-to-network, vehicle-to-mass transit, and vehicle-to-infrastructure; thus making an autonomous vehicle into a 'connected computer on wheels' (Sabella et al., 2017; Teece, 2017a). The autonomous vehicle is similar to the description of a 'circular car' given by the participant P5. It also shows that the automotive and IT/ ICT industries are converging more than ever before.

All these new technologies not only reduce waste of physical raw material resources, but also eliminate the idea of waste; thus, helping to decouple revenue growth from the consumption of resources. Yet another reason for linking the circular economy understanding to Industry 4.0.

However, the reality of a circular economy, i.e., the augmented waste hierarchy, undergoes further structural elaboration in the presence of Industry 4.0, automation, and resulting platforms and ecosystems. Conceptualising a circular economy as an ecosystem would offer a distinct form for organising economic activities that links to the specific type of complementarities valued in multi-sided markets, as explained by Jacobides et al. (2018) (see Appendix 7 and 8 and figure 3-1). In turn, it would help the business manager to understand and manage the ecosystem much better as compared to systems thinking, because, in systems thinking, the manager is bewildered to ascertain where his/ her firm lies in the entire gamut of the business value chain and beyond and how he/ she can create value. The circular economy business ecosystem would help the manager to coordinate his/ her firm's multilateral dependence. Such a business ecosystem would provide a tool for the manager to work towards co-specialization and cooperate and compete to create and capture value.

The time to create and capture value, from either a virgin resource or an easily recyclable resource, is reduced considerably in such an ecosystem centred around innovation and automation. The time factor is absent in the VRIN framework but Barney (1986) factored in the time component only in his conceptualisation of 'strategic factor markets', for ascertaining the cost of implementing a product-market strategy.

As a result of the above discussions, it is difficult to find out how valuable an easily recyclable raw material resource is, because the conditions of value, as set out in the VRIN framework, do not apply in the context of a circular economy. The 'valuable' condition has expanded by way of bifurcation in this context, in terms of value creation and capture, and it means more than neutralising threats and exploiting opportunities.

6.6.2 VRIN factors: Studying the relevance of 'Rare' characteristics in the circular economy context.

The 'R' in VRIN framework stands for 'rare resources' and rareness signifies the uniqueness of valuable resources, as shown by Barney's, 1991 p. 107); (Barney, 1997 p. 141) statement: 'If a firm's valuable resource is absolutely unique among a set of competing or potentially competing firms, those resources will generate at least a competitive advantage and may have the potential of generating a sustained competitive advantage'.

It was challenging to identify the easily recyclable resource that was unique among the investigated firms in both sectors, because the VRIN framework does not describe any physical evaluative parameter to identify uniqueness. The author found that the characteristics of the resources and their recyclate were not unique. However, the process followed for extracting services from the recyclate (in the language of Penrose) was unique, as shown in Tables 6-19 and 6-20 below. The process made the recyclate unique. Thus, uniqueness stemmed from processes backed by technology and conceptualised by managers with an engineering background. This process of instilling uniqueness in a recyclate shows that there is no requirement for a recyclate to be inherently rare. Therefore, this rare characteristic of resource in the VRIN framework is not significant in the circular economy business ecosystem, to achieve a sustained competitive advantage.

Table 6-19: Studying the relevance of VRIN characteristics in the Automotive firms

UK Automotive firms			
Investigated Firms/ Participants	**Rare**	**Imperfect imitable**	**(Non) Substitutable**
Firm 1/ P1	Designing aluminium alloys that lightweight the vehicles and are recycled infinite times. Designing unique alloy defines rarity.	Process of socially complex conditions (a) relationship with recyclers (b) both in the same value chain	Introducing metals or alloys or composites that can offset prime metals.
Firm 2/ P34	Rarity embedded by material reengineering and replacing aluminium parts with polymeric materials. Also developing own standards that are followed by Alliance partners, i.e. creating own network.	Process of combining virgin material with recycled material to get the properties required; applications could be costly to imitate.	Moving away from using metals and developing alloys and/ or composites that are (a) easily recyclable, (b) lightweight, (c) easily separable in their constituent atoms to be used in another applications.
Firm 3/P42	For them, the rarity stems from using new technology to manufacture products and developing a market-disrupting business model.	Process of technological innovation plus capacity and capability to integrate systems.	Focus on performance and developing business models that align with performance and decouple revenue.
Firm 4/ P2	Rarity is achieved through designing new alloys using recycled content or scrap/ used cans.	(a)owning mines (b) socially complex relationships with OEMs (c) historical position of the firm to access scrap/ used raw material, and own reverse logistics.	Develops new material using recycled materials to create multiple closed-loop processes.
Firm 5 / P47-P48	None found.	None found	None found.
Firm 6/ P32	Altering the physical and chemical properties of used polymers.	Inimitability achieved through (a) creating an in-house tacit knowledge base, and (b) collaboration for a continuous supply of raw material ‘the core’.	Builds using polymers altering the chemical structures so that they are used again in vehicle production.
Firm 7/ P5	The tacit knowledge acquired through products’ reverse engineering.	Tacit knowledge to evaluate broken automotive electronics part and developing own processes for remanufacturing.	Substituting batteries that store waste energy instead of Lithium-ion batteries that are environmentally friendly
Firm 8/ P8	Adaptability and building capability to deal with changing technology in the automotive market	The internal process of developing and documenting best practices.	Substituting new parts both metal as well as polymer-based through remanufacturing
Firm 9/P26	Market disruptors in the energy market - rarity is embedded through incremental innovation of storing wasted energy.	Process of identifying materials that could store wasted energy.	Substituting new parts both metal as well as polymer-based through remanufacturing.
Firm 10/ P30	Rarity is achieved through material coating and maintenance that extends products’ life.	Sensing what could go wrong - developing expertise in material chemistry.	Advises reuse and intelligent design of materials.
Firm 11/ P4	None found - not directly involved as it is a consultancy.	No evidence of inimitability.	Disseminates knowledge of best practices and ways and means to reduce waste and use unavoidable wastes.

Table 6-20: Studying the relevance of VRIN characteristics in the IT sector

The UK IT Sector			
Investigate firms/ Participants	**Rare**	**Imperfect imitable**	**(Non) Substitutable**
Firm 12/ P11	Providing product - as service servitization	Tacit knowledge to combine virgin and used material.	Introduce 'product as a service'.
Firm 13/ P49	Global forward and reverse supply-chains.	Tacit knowledge to recover precious metals.	None found.
Firm 14/ P14	None found.	None found.	Substitute faulty and old equipment with used.
Firm 15/ P18	Budgets allocated for developing alternative or new materials.	None found.	Substitute faulty and old equipment with used.
Firm 16/ P3	Altering chemical structures of materials for product functionality.	Knowledge of new technology.	Use only materials that are flexible and adaptive.
Firm 17/P33	Find a substitute or an alternative raw material. Digitalisation, machine learning. AI used for less use of resources.	None found.	None found.
Firm 18/ P45	Apply design thinking to use fewer raw materials.	Dematerialisation and recycling.	Design materials that are flexible and adaptive.
Firm 19/ P9	Reduced dependency on expensive materials.	None found.	None found.

However, the examination showed that capabilities are critical, particularly the tacit knowledge possessed by the managers, which is a dynamic capability (Teece et al., 1997 p. 510). Such explicit and tacit knowledge is an engine of change, and central to a firm's capability, argues Zollo and Winter (2002a); Zollo et al. (2002b); Zollo et al. (2013). Such capabilities are intangible assets, contends Sanchez and Heene (1997) and Sanchez (2001, 2004), and are challenging to manipulate (Polanyi, 1962).

Also, it was difficult to ascertain if the number of firms possessing a common valuable recyclate was less than the number of firms needed to generate perfect competition dynamics in the circular economy industry. This was because it is still in a nascent stage - the second condition of Barney (1991 p. 107) for achieving the sustained competitive advantage. His critiques (Priem and Butler, 2001a) argues that the explanation offered for the rareness condition is very loose in the RBV framework, which is consistent with the findings of this research study. The researcher too experienced difficulty in identifying rare resource(s) within investigated firms.

A rarity in VRIN (ibid) is at the crossroads when applied to a circular economy business ecosystem. It is because competing with firms within the same industry and securing future cash flows is not the end game in a genuine circular economy business, as it is in the case of a rare resource in a conventional market. The real danger to the genuine circular economy is from those firms chasing profits for selfish ends, diluting the genuine circular economy's novel and noble purpose.

6.6.3 VRIN factors: Studying the relevance of 'Inimitability' characteristics in the circular economy context

According to Barney (1991 p. 107) and Lippman and Rumelt (1982, 2003), imperfect imitable characteristics could arise due to one of three reasons. These reasons are (a) if a firm can acquire and accumulate the resources based upon their unique historical conditions, (b) the relationship between a firm possessing a resource and its achieving a competitive advantage is causally ambiguous, and (c) resources that create a competitive advantage are socially complex/ involved.

The way Case companies are practising closed-loop recycling, the leasing model, and product-as-service, currently resonates well with the conditions listed in (a) and (b) above. However, while such practices can ensure a competitive advantage, it does not address the other two dimensions, i.e., environmental, and societal, of the circular economy, with the much-needed emphasis and clarity

A condition that encourages blocking others from acquiring resources, with the sole purpose of earning above-normal profits, is not part of the characteristics of the right kind of circular economy or the Advanced Circular Economy. Therefore, in principle, the Advanced Circular Economy does not support the idea of maintaining ownership of resources for economic profit alone. Investigated Case companies that benefitted through unique historical positions are Firms 1(P1), 4(P2),16(P3), and 13(P49) - each has a different causal mechanism, identified in Tables 6-19 and 6-20. For example, automotive Firm 1 collaborates with the recycling Firm 4. It collects scrap from firm1 shopfloors to reprocess it as ingots supplied back to them. As a result, it reduces raw material resources costs and maximises profits for firm 1 and ensure a steady supply of core (used raw materials resources) for firm 4. In this manner, the firm can check for contamination and maintain an uninterrupted supply of its raw material resources while ensuring continuous business and profits.

Similarly, the participant P2 says that his company maximises returns by owning mines in developing mineral-rich countries, and producing the raw materials that require very high energy in the same country, where environmental legislations are not strict. The participant, P49 says his company engages in recovery because they require the rare precious group metals. Participant P3 says that his company has a new technology that is flexible and compresses time to bring a product to market, but they have been accumulating raw material resources to hedge price risks and create entry barriers (Dierickx and Cool, 1989; Cool et al., 2012). These Case companies can be said to be practising a Standard Circular Economy but not the Advanced Circular Economy.

Maintaining historical positions does not offer definitive proof that such types of firms can achieve sustained competitive advantage. However, it does offer firms cost leadership (Porter, 1985), thus bringing back the debates on firms' performance heterogeneity to focus on product market (Porter, 1980, 1981, 1985), rather than on the resources positions that firms' take (Wernerfelt, 1984; Barney, 1986). Also, it brings to the forefront the debates on Barney's strategic factor markets (Barney, 1986). In circular economy parlance, the secondary materials market (Velis, 2015; Söderholm and Ekvall, 2019) resembles the strategic factor market as Case companies pick used resources from recycling markets, and adopt various means to maintain a steady supply of used automotive and electronic components for staying afloat.

A strategic factor markets concept differs from the secondary materials market concept because, in the former, the aim is to maximise revenues alone, i.e., the focus is on the economic dimension only. In the latter, it includes the environmental and societal dimensions as well. Therefore, the requirements change. In the former, the manager's business capability is central in determining the revenue-generating potential of the acquired resource, and the cost of acquiring the resource needs to be less than the economic value of that resource in implementing the product-market strategy for achieving competitive advantage. Whereas, in the latter, the manager's business, as well as technical, capabilities are needed for ascertaining the extractable residual capacities of a resource. Therefore, managerial capabilities are essential, in addition to the historical positions of a firm's resources position.

The second condition, (b) for inimitability is vague. That is, the 'link between resource possessed by a firm and competitive advantage should be causally ambiguous'. This condition does not leave any room to identify and test processes that help to achieve a competitive advantage amongst participating firms. It is consistent with Priem and Butler (2001a pp 33) describing RBV as a black-box.

A new set of conditions have emerged for preventing imitation, apart from the 'causally ambiguous' and 'socially complex' conditions, and these are:

(a) Tacit knowledge for generating inimitable resource - P5, P9, P30, P32, P45, P49.

(b) Material innovation, i.e. capability to alter material chemistry - P3, P8, P9, P11, P26.

(c) Collaboration - P1, P2, P3, P32, P5.

(d) Integration capability - P26, P45, P42, P49.

The above conditions are dynamic capabilities, consistent with many scholars (e.g. Teece, 1986; Grant, 1996; Teece et al., 1997; Eisenhardt and Martin, 2000; Zollo and Winter, 2002a; Winter, 2003; Bowman et al., 2009; Teece, 2012, February; Zollo et al., 2013; Schilke, 2014), and can be termed as resources only if resources are defined as all-inclusive, as has been done by Penrose (1959), Wernerfelt (1984), Rumelt (1984), Barney (1991), and many other strategic management scholars.

According to Posen and Martignoni (2018 p. 1353), imitation does not reduce, instead it increases inter-firm performance heterogeneity, because the experiential learning of imitation helps the imitator to refine the imitated practices and fill the remaining knowledge gap. They argue that erosion of performance heterogeneity due to imitation is an assumption made by neo-classical economists, which other theoretical perspectives question. According to the evolutionary economics perspective, re-combinative process due to limited or incomplete observability, or a mistake in imitation of the target's practices, could lead to new combinations and new configurations that are unique in their own right (Lippman and Rumelt, 1982; Winter and Szulanski, 2001). Such an imitation is consistent with Open-Source technology and advances the cause of an Advanced Circular Economy. Also, cooperation rather than competition supports the Advanced Circular Economy (Alchian and Demsetz, 1972 p. 777), signifying that co-opetition (Akpinar and Vincze, 2016; Cozzolino and Rothaermel, 2018; Cozzolino et al., 2018) is more relevant as opposed to competition in the Advanced Circular Economy.

Thus, inimitability is not significantly relevant in an Advanced or Standard Circular Economy context, as there is the emergence of an entirely different set of rules for the competition. The competition no longer depends only on products and markets; instead it is about creating and owning a network, deriving values of resources in multiple markets where co-opetition is more favoured, as depicted in figure 3-1(Brandenburger and Nalebuff, 1996; Brandenburger and Stuart, 1996; Cozzolino and Rothaermel, 2018; Cozzolino et al., 2018; Jacobides et al., 2018). However, co-opetition does not come without tension for firms as there are an entirely different set of tensions to manage (Seran et al., 2016), which is beyond the scope of this research.

6.6.4 VRI<u>N</u> factors: Studying the relevance of 'Non-Substitutability' characteristics in the circular economy context

Barney's (1991 p. 111) fourth condition of non-substitutability means that there should not be any strategically equivalent valuable resources that are themselves either not rare, or imitable. It means, two valuable resources are strategically equivalent if the firm employs either one of the two individually to implement the same strategies.

Again, this non-substitutability does not align with the characteristics of either an Advanced or a Standard Circular Economy. The practising firms are always on the lookout for materials to embed circularity in them, i.e., make them recyclable, to reduce dependence on virgin raw material resources. The endeavour is to find a substitute for those materials that are scarce and expensive - substitutability in an inherent characteristic of both an Advanced or a Standard Circular Economy.

Tables 6-19 and 6-20 show that non-substitutability (ibid) for a valuable and rare recyclate stems from explicit and tacit knowledge (Zollo and Winter, 2002a; Coff and Kryscynski, 2011; Felin et al., 2012).

Barney (1991) did not consider natural raw material resources[53] for non-substitutable characteristics, which indicates the practical difficulties in finding a natural material resource that has all the four VRIN characteristics present at one time, without capability intervention. Also, the absence of physical material resources in Barney's (ibid) non-substitutability explanation validates Teece (2014a) explanation. That is, a on its own cannot be valuable unless until managerial expertise in the form of tacit knowledge or intellectual capital is applied to make it valuable, which are unique for its customers. Teece's (2014a) explanation is consistent with valuable, rare recyclate as well. Tacit knowledge, top management teams (TMTs), and the manager's role, are dynamic capabilities that are required to respond to the chaotic and complex business environment. They are also considered central to achieving a competitive advantage. This is also the case for the investigated Case companies in both sectors (Eisenhardt, 1989b; Teece et al., 1997; Augier and Teece, 2009; Helfat and Martin, 2015; Helfat and Peteraf, 2015).

It implies that while valuable and rare recyclable resources help a firm to achieve a competitive advantage, it is inimitability and non-substitutability that sustains the competitive advantage achieved through valuable and rare recyclable resources. Therefore, the sustainability of competitive advantage stems from dynamic capabilities, because in order to realise the power of inimitability and non-substitutability, explicit and tacit knowledge and intellectual capital

[53] Therefore Hart (1995) came up with N-RBV.

(dynamic capabilities) are essential, which is consistent with the argument put forth by Talaja (2012 p. 54).

Conclusively, the VRIN framework is not fit for purpose in the context of a circular economy. It has undergone both structural elaborations as well as transformation. It needs rethinking in the context of waste, the ways resources get deployed in combinations or clusters, and more broadly, in an Advanced and a Standard Circular Economic business ecosystem. It is consistent with Teece's (2014a p. 17) assertion that the RBV is not enough when the value of resources is fleeting in a fast-paced business environment. There is a need for an extended paradigm. Accordingly, the evolved circular economy business ecosystem needs a distinct set of resources to enable a firm operating within it to achieve sustained competitive advantage. Barney et al. (2011 p. 1312) also acknowledges this and says, 'resource-based theory scholars need to be mindful of the need to innovate how RBV explains important relationships' in the different organisational contexts.

While RBV's VRIN requires reconceptualization, the dynamic capabilities framework has adapted itself from time to time. (Teece, 1986; Teece et al., 1997; Teece, 2007, 2014a, b, 2017a, b, 2018b, 2019a). Those firms with dynamic capabilities would be able to create and capture value from recyclate resources or qualify to be within the real circular economy business ecosystem. It means that both types of circular economy bring about a change to the existing circumstances of a firm and are a dynamic capability in their own right. (Khan et al., 2020 2923) echoes the same argument that the author put forth.

6.6.5 The emergence of a 'New Competitive Advantage'

From the above discussions, we can conclude that a joint presence of three conditions is necessary for creating and capturing value. These are the inherent productive capacities present in raw material resources, the manager's capabilities to sense and seize such productive capacities, and the firm's infrastructural capabilities for extracting productive capacities.

However, for a circular economy to deliver the other two dimensions (environmental and societal benefits), a firm needs to follow the Intent-Practice-Outcome model, in addition to these three conditions.

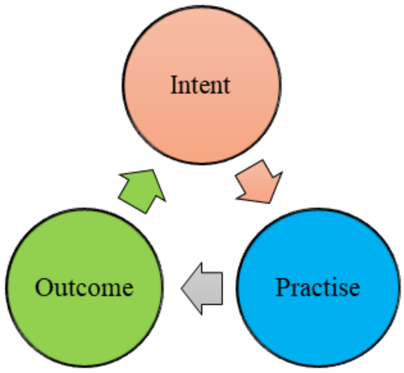

Figure 6-10: The IPO for realising the circular economy. Source: Author (2020)

Figure 6-10 is a conclusion resulting from the above findings, analyses, and discussions. The findings and analyses show the presence of theory-practice contradictions, i.e., when a firm claims to practise a circular economy, but in reality, it practises recycling alone underpinned by maximising revenues for profit. That means there is a difference between Saying and Doing, similar to Seeing and Doing as identified by Joseph et al. (2018).

A growing number of participants/ firms (twenty-six per cent – P3, P13, P17, P26, P28, P38, P40, P42, P45) strongly argue that wellbeing and environmental protection should be a part of profit calculations. They emphasize that the accounting principles should also change if we expect all businesses to practise a circular economy. These participants also believe that it is difficult to achieve a circular economy if the logic of profit is maximizing revenues alone. Additionally, Eisenhardt and Martin (2000 p. 1113) have signalled that following competitive advantage in turbulent business environments increases entropy. Therefore, it is not the competition per se that is helpful for the environment, but co-opetition. However, there is no decisive research that the author has come across to prove whether competition or co-opetition is more harmful to the environment.

However, the multi-sided markets and platform ecosystems (see Appendix 7 and 8 and figure 3-1) indicate that the era of collaboration is on the horizon, where competition would either wane or elaborate with new meanings.

Therefore, all of these assertions point towards the organisational intent and the sincerity of practising a circular economy (Cantrell et al., 2015). That means if a firm's intent in practising a circular economy is to create environmental and societal benefits, then it will not maximise revenues alone. The firm would engage in prudent practices, e.g. lowering consumption. These prudent practices, in turn, would result in the right outcomes, e.g. decoupling revenue growth from resources consumption. The firm would be able to achieve revenue growth despite using less raw material resources or selling fewer products/ services. In turn, this outcome would further motivate the firm to reduce theory-practice contradictions, strengthening its intent to act wisely. It means it is possible to increase revenues while consuming less or selling less. The logic of profit would be sales minus costs and the savings of natural raw material resources and well-being delivered.

According to Rumelt (2003), the competitive advantage concept's problematic issues are costs and profit, including how value is conceptualised and measured.

Lowering the consumption of raw material resources would lower production costs. Internalising the external costs and changing the accounting principles would change the logic of profit if done with the intent of benefitting each member of society. As a result, it will change the concept of competitive advantage. Industry 4.0 and 5G Internet Technologies allow us to simulate production processes before using physical natural raw material resources for actual production. They lower the marginal cost of production and drive it to near zero (Rifkin, 2014).

The drive to lower consumption by UK government agencies and to achieve zero waste has led to a variety of consumption patterns such as (a) product-service systems or servitization, (b) redistribution markets, and (c) collaborative lifestyles, giving rise to 'Commons', e.g. industrial commons, creative commons, and collaborative commons (Stahel, 2006; Baines et al., 2009; Botsman and Rogers, 2010; Botsman, 2014; Rifkin, 2014; Teece, 2017a; Bailey et al., 2018).

The rise of Collaborative Commons, and the change in consumer perception regarding sharing and accessing products and services, presents an opportunity to conceptualise a new competitive advantage. This new emergent competitive advantage would address economic, environmental, and social dimensions and stem from business strategies based on the perspective that 'small is beautiful' (Schumacher, 1973). Again, the new competitive advantage would not be a brand-new concept.

On the other hand, considering the turbulent business environment under which a circular economy operates, achieving a competitive e advantage and sustaining it could be challenging. A recyclate could only create a fleeting value as it is simpler to complement the recyclate (e.g. P34). Complementing a recyclate is consistent with Teece (2014a p. 17) as he argues that in high paced environments, even resources have fleeting value. Therefore, it would be the 'transient competitive advantage'(McGrath, 2013a) that comes into effect. Firms would enjoy the differentiation created only for a certain period, as any other complementary assets could wipe it out. There would be different complementary assets at different times for creating and capturing value, argues Teece (2018b).

The new competitive advantage is relevant to the sharing economy as well because it disrupts hyper-consumption through the use of technology platforms. It supports the co-opetition concept. In co-opetition, a firm team up with its customers, suppliers, complementors, and competitors. Each agent thinks of competing and co-operating at the same time to change the game (Brandenburger and Nalebuff, 1996; Brandenburger and Stuart, 1996; Akpinar and Vincze, 2016; Teece, 2018a). It is also consistent with the orchestration theory of Pitelis for achieving sustainable competitive advantage for multinational enterprises (2018).

Thus, this new conceptualisation of competitive advantage will automatically lead to new business models for creating and capturing value in circular economy business ecosystems. In this context, the competitive advantage is more about how a business strategy helps lower consumption yet creates business benefits and instrumental in reducing or eliminating the dichotomies and paradoxes within the economy.

Competitive advantage would also include redistribution of business benefits and sharing responsibilities amongst all agents and actors within society. Therefore, the new competitive advantage is summed up as *'I benefit if you benefit'*. Conclusively, a circular economy has all the power to become a paradigm to change the world for a better future.

6.7 Policy implications

The emergent competitive advantage that inherently makes it mandatory to redistribute business benefits and creates an inclusive society requires policies that support it. Therefore, the analyses and discussions are grouped into (a) Insights (b) Implementation (c) Impact and (d) Impending future and tabulated to show the way each of the 4Is informs the different policymaking areas presented in Tables 6-21 and 6-21-1 below.

(a) **Insights:** about the circular economy, i.e., the augmented waste hierarchy best describes the circular economy, and closed-loop recycling is the next closed concept describing the circular economy.

(b) **Implementation:** The circular economy's implementation takes various forms, and the most popular form of implementation is recycling with advanced technologies driving it. The investigated firms recognise that waste is a new resource, but this seldom gets translated into action. Usually, firms manage their waste under an environmental policy or as a compliance activity. A gap (theory-practice contradictions) has been identified in terms of 'saying and doing' in the investigated firms. In turn, it leads to the emergence of two types of a circular economy being practised, a Standard Circular Economic, an Advanced Circular Economic driven by the organisational intent.

(c) **Impact:** The circular economy impacts a firm's raw material resources use, i.e., a resource that can be recycled multiple times and easily substituted is more valuable. It leads to the emergence of a new form of competitive advantage, buttressed by both competition and cooperation. The augmented waste hierarchy also gives rise to multi-sided markets (see Appendix 7 and 8 and figure 3-1), offering new business opportunities for maximising revenues, thereby decoupling revenue growth from the consumption of resources.

(d) **Impending future**: The circular economy is a dynamic capability that can address the age-old tensions of managing all the three dimensions, i.e., environment, economics, and societal, at one time by private firms and government agencies alike.

Each group is crucial for UK manufacturing considering the current COVID-19 crises and Brexit confusions. As an example, the circular economy's insights inform 'environmental development policy', the European Commission's Circular Economic Action Plan'. It would provide a uniform understanding of the circular economy across all sectors, thereby paving the way for converging different efforts taken to decouple revenue growth from the consumption of raw materials resources.

Likewise, the impact of the circular economy on a firm's use of its raw material resources informs the theory development of the circular economy for building regional ecosystems to support regional SMEs, which, in turn, would help in co-creating regional value (Bailey et al., 2018). From the theory development perspective, identifying a circular economy as a dynamic capability opens avenues for future research in the circular economy field of scholarship. Therefore, the insights, implementation, impact, and impending future (the four Is) profoundly impact policymaking if the collective intention (of both private firms and government agencies) is to make the circular economy mainstream. The implications of 4Is on policymaking are elaborated below.

Table 6-21:Prompts for policymakers

Resulting insights and impacts			
Groups	**Insights from the analyses and discussions**	**Impact**	**Prompts for Policymakers**
Insights about the Circular Economy	An augmented waste hierarchy best describes the circular economy in the investigated UK manufacturing firms and government agencies	Informs both the Policy and Practice perspectives	1.The need for developing a series of Knowledge Transfer Networks (KTN) networks to promote a uniform understanding of the circular economy. Also informs DEFRA's Environmental Developmental Plan (HM Government, 2018, 2020)
	The augmented waste hierarchy is heavily linked to advanced technologies such as Industry 4.0.		2. The need to connect the Waste Hierarchy, Industry 4.0 and Innovation
			3.Informs Industrial Strategy development. The need to have 'Industrial Data Governance' Policy (HM Government, 2017)
Implementation of the Circular Economy	Two types of the circular economy (a) a Standard Circular Economy, and (b) an Advanced Circular Economy is in practice.	Informs both the Policy and Practice perspective	4.Informs the Circular Economy Action Plan constituted by European Commission, World Economic Forum, UNEP, OECD, and others. (European Commission, 2018; UNESC, 2018; European Commission, 2020a)
	Gap between 'Saying and Doing'		5.Informs policy on sustainable growth (European Commission, 2020a; UAE Government and United Nations, 2020)
	Waste is the new resource		6.Helps in developing resource guidance and practical examples for delivering the circular economy programmes by local authorities and DEFRA's delivery partners - WRAP, Local Partnerships, and Local Councils.
	The emergence of multi-sided markets		
	Lack of coordination between Government agencies implementing the circular economy locally.		
	Lesson from the Welsh Government - Move the circular economy from the Natural Resources department to the Economy department		
Impact of the Circular Economy on a firm's raw material resources use.	SMEs are more flexible and agile than large MNCs.	Informs both theoretical and practice perspective.	7.Informs development of Policy for Regional Growth, such as 'Reshoring Policy' and for creating clustering, co-location, and building regional ecosystems, to support regional SMEs, for co-creating value, fostering embeddedness and achieving 'regional stickiness'(Bailey et al., 2018; Bailey et al., 2019a)
	Circular economy is easier to manage within regions than globally		8.Informs New Industrial Strategy for Europe - Competition Policy (European Commission, 2020a)

Table 6-21 1: Prompts for policymakers

Groups	Insights from the analyses and discussions	Impact	Prompts for Policymakers
Impact of the Circular Economy on a firm's raw material resources use	Circular economy growth is bottom-up.	Informs both theory and practice perspectives..	9.Informs UK Industrial Strategy for developing UK Manufacturing SMEs, addressing regional disparities and creating resource-based cities (Bailey and Rajic, 2020; Ruan et al., 2020)
	RBV-VRIN framework is not suitable to achieve competitive advantage for circular businesses		10. Informs the avenues for revitalising RBV theory (Barney et al., 2011)
	Circular economy brings 'Change', and therefore a dynamic capability.		11. Informs the upcoming Teece's 'A capability theory of the firm', and relationship between resource allocation and firm's performance (Teece, 2019a; Lovallo et al., 2020)
	The emergence of New Competitive Advantage based upon coopetition and collaboration rather than competition.		
Impending Future	The circular economy is a paradigm that address the age-old tensions between economic, environmental, and societal dimensions.	Informs theoretical perspectives	12. The potentials of the circular economy, the identified conclusions, paradoxes, and dichotomies can be addressed through policy instruments. The Circular Economy offers to decouple economic growth from the consumption of raw material resources while embedding, wellbeing and generational equity.

6.7.1 Establishing a Circular Economy Knowledge Transfer Networks (CE-KTNs)

Having identified that 'an augmented waste hierarchy' best describes the circular economy and knowing that there is a need for a unified understanding of the circular economy, establishing a circular economy knowledge transfer networks is the most prudent thing to do. It will allow the policy makers to converge all efforts for addressing critical issues facing UK manufacturing. The augmented waste hierarchy is easy to understand, implement and practise. Therefore, setting up circular economy knowledge transfer networks would go a long way towards establishing a unified and agreed understanding of the circular economy across the private firms and government agencies and foster 'public-private partnerships' (PPPs) to deal with the menace of climate change and the plastics, which require urgent attention.

In the private sector, if manufacturing firms across all sectors, e.g., automotive, IT, aerospace; at the regional, national, and global level, understand the universal reality of a circular economy it will help them to focus their efforts and reap benefits across the three dimensions - economic, environmental, and societal.

A review of the European Commission's 'circular economy action plan' reveals an ambiguous picture of the circular economy, similar to the theory-practice contradictions identified in the investigated automotive and IT firms. The EU's resource efficiency agenda is in a position of unchanging status quo, possibly because it has fallen into the joint-decision trap, similar to that experienced by German federalism and decision-making in the European Community (Scharpf, 1988; OECD, 2018). As a result, the European Commission resources conservation policies favour only incremental policies, rather than radical policy approaches (WEF, 2014; Domenech and Bahn-Walkowiak, 2019). Although the properties of a circular economy identified in the actual and empirical domains are consistent with the European Commission's (2015a) conception of a circular economy, at the ground level the circular economy is implemented as a waste hierarchy, as shown from the responses of outer case nest, Case 3- EU participants. Considering the EU's initiatives and its results, setting up a 'Circular Economy Regulatory Authority' under the United Nations umbrella would help in addressing similar inconsistencies. This Circular Economy Regulatory Authority, using KTNs, could control, validate, and disseminate the correct pieces of information relating to the circular economy, thus enabling a unified understanding of it

6.7.2 Connecting the Waste hierarchy Innovation and Industry 4.0

It is evident from the circular economy literature review in Chapter 2 that Industry 4.0 is an enabler of the circular economy. It connects resources, services, and humans throughout the production processes in real-time and functions on the back of an IT architecture (Lopes De Sousa Jabbour et al., 2018; Rajput and Singh, 2019; Chiappetta Jabbour et al., 2020).

The description of a circular car by the inner case nest Case 1, participant P5 (firm 7) is similar to the Autonomous Vehicles (Computers on Wheels), and the options to go for Cloud-based production processes are supported by and consistent with Industry 4.0. We also know that a circular economy or an augmented waste hierarchy leverages the technological innovations to conserve resources through different 4R processes (Charro and Schaefer, 2018; Stock et al., 2018; Tseng et al., 2018). However, the absence of the waste hierarchy from government strategy documents (HM Government, 2017, 2018) and the absence of both the circular economy and a waste hierarchy in 'Regulations for the fourth Industrial Revolution' and the 'State of Natural Capital Annual Report, 2020' (HM Government, 2019, 2020) signals a lack of understanding about the prowess of a circular economy. The Industrial Strategy (HM Government, 2017), despite recognising and stressing innovation as a critical driver in all facets of economic development and dealing with limited raw material resources, does not link all three under one umbrella, i.e., innovation, the circular economy (or an augmented waste hierarchy), and Industry 4.0.

This linking is essential to create a 'By-product Exchange Network' model (BEN *c.f.* footnote no. 12) for creating value, particularly at a time when there are acute raw material shortages resulting in high resources-price volatility. On top of this the UK manufacturing is suffering because of uncertainties regarding tariffs and trading relations with tier 1 and tier 2 suppliers post-Brexit, as well as the recent Covid-19 crisis, and the long-term challenge of ecological sustainability (Bailey and Rajic, 2020). Restarting the economy after Covid-19 lockdown could be facilitated by a BEN network as it leverages technological innovation to create new market structures, disrupting the conventional ones, and transforming ways of manufacturing things. As an example, the 5G network capabilities, Industry 4.0 (machine learning and artificial intelligence (AI)) enabling the autonomous circular car can help to revive the economy, including both the automotive industry and IT sector. In this new way of working, recycling would be led by Artificial Intelligence-driven Recycling Robots, thereby opening the possibility of extracting more productive use from waste, while minimising wastages in the processes, as reported by Clancy (June 18, 2019) in 'Green Biz.'

The converged automotive and IT industries would witness consolidation in terms of players. Each large OEM would have their own set of competitors, complementors, customers and suppliers, i.e. their value network or cyber business ecosystem (Brandenburger and Nalebuff, 1996; Brandenburger and Stuart, 1996; Akpinar and Vincze, 2016; Monostori et al., 2016; Cozzolino and Rothaermel, 2018; Cozzolino et al., 2018). The circular car, just as any autonomous car, allows integration of various modes of transport along with single payment function, giving rise to 'mobility-as-a-service-MaaS', according to the Department for Transport in their March 2019 report (Department for Transport, March 2019). Several environmental and societal benefits stem from MaaS. For example, (a) MaaS would reduce road congestion resulting from lower car ownership, thereby reducing CO_2 emissions, (b) it would free up spaces in big cities as car parking would reduce significantly, and (c) it would increase recycling and the green environment as modularity in autonomous vehicles comes to the forefront. This kind of technological innovation is consistent with neoclassical economists thinking, that new technologies would economise the impending scarcity of natural raw material resources[54]. However, several heterodox economists have suggested that technological innovations provide societal benefits more than they benefit the innovator (Griliches, 1957; Mansfield et al., 1977 p. 234; Teece, 2018b pp. 1371 and 1380).

6.7.3 Supplementary raw material resources market

Europe produces only one critical raw material, Hafnium, out of the twenty-seven critical raw materials identified by the European Commission (2018 p. 5). China and a few Asian countries produce the remaining twenty-six. These critical raw materials are crucial for both the automotive and IT firms. For example, several components of internal combustion engines, electric vehicles, and hybrid electric vehicles, contain these critical raw materials - for example, graphite (used in brake linings, exhaust systems, motors, clutch materials, gaskets and batteries), cobalt (used in lithium-ion batteries, especially for EVs), precious group metals (palladium, platinum and rhodium, used as auto-catalysts and particulate filters), niobium (used as an alloying agent in high-strength steel and nickel alloys used in the body structure, engine system and structural components) (Cullbrand and Magnusson, 2013).

Similarly, all the additives and auto-catalyst filters used in a vehicle contain rare earth elements (European Commission, 2017b). A lack of 'critical raw material reserves create pressure to find ways and means to hedge the raw material resource supply risks. As a result, the government pushes recycling and discourages the use of virgin resources by introducing stricter legislation on recycling. In response to stricter legislation around recycling and the use of virgin raw material

[54] *C.f.* footnote number 6

resources, the large OEMs and other big players create their own closed-loops involving their supply chains. As a result, those small and medium recyclers and remanufactures that are not a part of large OEM's supply chains are left out, and they face the challenge of sourcing a steady supply of used mechanical and electronic automotive components (often referred as 'the core' by recyclers and remanufacturers). It creates a disparity in the recycling market as the first-rate quality recyclate does not come into the open market because large OEMs keep them under their control through their closed-loop operations. Also, it puts the large OEMs in an advantageous position, allowing them to dictate their terms with the small and medium recyclers and remanufactures who compete to be in the list of their approved suppliers. As a result, the role of the secondary materials market is undermined. The larger purpose of promoting recycling to save critical raw materials resources is lost.

Also, due to frequent changes in waste collection policies, the recyclers and remanufacturers are not able to realise their investments. Hence, it does not make a compelling business case for them. This is consistent with Usubiaga's findings that after years of investing in incineration, which resulted in an expensive incineration infrastructure, the European Commission shifted its focus, promoting recycling, and setting targets, thereby limiting waste going to incineration (Usubiaga et al., 2011).

The creation of a non-discriminatory supplementary raw material resources market, backed by appropriate legislation that facilitates bringing all critical raw materials into this centralised supplementary market, would go a long way to address the dichotomies and paradoxes associated with a circular economy. It would also help the government to control the prices and manage the reserves of critical raw material resources more effectively.

The role of supplementary raw material resource markets in restarting the economy post Covid-19 and Brexit becomes more important than ever, because the UK automotive is already hugely distressed. The auto industry was already experiencing a 'perfect storm' before Covid-19 because of the move away from diesel engines, the Chinese market facing a downturn, and Brexit uncertainty impacting on auto sales and production, which in turn, further lowered margins. With Covid-19 the distress is further amplified, with supply chains disrupted, assembly lines closed, car dealerships shut, and increased pressure on OEMs to invest in new technologies due to the onslaught of Industry 4.0. In the words of Bailey (2020 p. 1), Covid-19 is like the 'Perfect Storm Part 2'. The way of revival seems to be in turning towards practising the Advanced Circular Economy, i.e., 'encouraging buyers to trade in older cars and switch to electric and hybrid models' (Bailey, 2020). Turning to the circular economy would not only help reduce CO_2 emissions, but also help the switch to the new business models (e.g., MaaS). It would also bring down the cost of production, as well as reducing the strain on the reserves of raw material resources.

Most of the participants have suggested a ‘secondary materials market’. The author agrees that a nomenclature such as a ‘secondary materials market’ would be consistent with the ‘strategic factors market’ conceptualised by Barney (1986). However, the term ‘secondary’ may convey that the ‘raw material resources’ are of low grade. This is because ‘secondary’ is usually linked with ‘something less’, ‘subordinate’, or ‘non-essential’. Moreover, recyclates cannot be considered as secondary because of their capacity for productive use, which is consistent with Penrose’s (1959 pp. 25 and 83) assertions that ‘…it is not the resource that matters, but the productive services that a resource renders’ and ‘…unused productive services are, for the enterprising firm, at the same time a challenge to innovate, an incentive to expand, and a source of competitive advantage’. So, firms such as an inner case nest Case 2, firm 17 competing in a ‘secondary material market’ or ‘recycled market’ may offer different uses for the same resource, using technology. Each client may use the resource differently, i.e., depending upon the chemical configuration that each recycler or remanufacturer has come up with, and accordingly, they plan to combine it with different complementary resources to extract value.

A ‘supplementary market for materials’ may or may not help firms acquiring recycled material to achieve a competitive advantage, but it will surely help firms to reduce their carbon footprint, which is another way of realising competitiveness, thus creating societal value.

Creating such supplementary markets for either critical or non-critical raw materials would also augment the EC’s resource diplomacy strategy, helping them to foster closer relationships and better co-ordination with other EU member states, thereby addressing the ‘joint-decision trap’.

6.7.4 Urban Mining policy and the Natural Capital policy

Increase in recycling of waste could in principle reduce consumption of primary raw materials, and reduce CO_2 emissions, but it is not clear yet if increased material recycling has contributed to substituting the demand for primary resources (Fellner et al., 2017). Also, increasing recycling does not guarantee lower consumption or making the closed-loop tighter, i.e. there may be high consumption of materials that is going round in circles, and each subsequent circle keeps getting bigger.

Similarly, the negative impact of landfilling policies led to the circular economy package including a limit to landfilling of municipal solid wastes (MSWs). Such policies have led to an increase of MSWs directed towards incinerations and to the construction of waste-to-energy plants (Merrild et al., 2012).

The need for ensuring a steady supply of the used electronic and mechanical components and for recovering scarce materials to support SMEs in the recycling and remanufacturing sectors have brought ‘Urban Mining’ to the forefront. Additionally, Urban mining has gained prominence because the European Commission (2017a) has identified recycling as a strategy to reduce waste and to deal with metal scarcity (European Commission, 2017b). It has resulted in a mushrooming of scrap collection yards, which have become a highly disorganised and unstructured business segment within waste management. The current recycling industry is not able to deal with complex waste streams of end-of-life vehicles, and electrical and electronics equipment (Andersson et al., 2019). Despite the strict End of Vehicle Life and Electronic Wastes (WEEE) regulations by the European Commission, this business segment witnesses a high level of irregularities.

5G Internet and Communications technology has made it possible to extract more productive use from wastes. This research showed the need to reconceptualise VRIN factors in the context of a circular economy, and the emergence of new competitive advantage. All of these changes are compelling businesses to rethink their competitive strategies and are blurring the sectoral boundaries[55] (Teece, 2017a, 2018b), making resource acquisition more challenging. In this emerged scenario, urban mining policy, which is currently absent from the government’s active consideration, needs urgent attention.

The UK Government published the UK Industrial Strategy document in 2017, (HM Government, 2017). DEFRA published its 25-year plan to improve the environment in 2018 (HM Government, 2018) introducing the Environment Bill. The Natural Capital Committee presented its report on Natural Capital in January 2020 (HM Government, 2020). The circular economy gets a mention only once in the industrial strategy, on page 48 in DEFRA’s 25-year plan, and there is no mention of the circular economy in the Natural Capital Committee’s report. In the absence of mineral mines, such as iron ore, limestone, and precious metal groups, in the European Regions, there is a need to reconsider the Natural Resources Policy - more so, due to Brexit when the UK is left alone to fend for itself. If essential mineral resources can be made available to all manufacturing firms on a non-discriminatory basis, discouraging private ownership of raw material resources, this in turn, would encourage firms to compete based on performance of their products alone, thereby buttressing the idea of decoupling revenue growth from the consumption of resources. It would also help firms switch to new business models, thereby brining MaaS centre stage.

[55] *C.f.* Tables 3-9 and 3-13

6.7.5 Industrial-ecosystem policy

The shifting of all business activities to technology platforms in the wake of the COVID-19 pandemic has fast-forwarded the transition of business activities to technology platforms. It has also demonstrated the importance of technology platforms for value creation and capture at regional, national, and global levels (Bailey et al., 2018; Jacobides et al., 2018; Teece, 2018a,; Pitelis and Teece, 2018). From the Chapter 2 and 3 literature reviews, we know that platform innovators largely govern how an ecosystem would work. That is, the viability of any business ecosystem depends upon the platform innovator cooperating with the providers of complements and vice versa. Therefore, for a circular economy business ecosystem (CEBE) to reap the benefits of multi-sided markets created by technology platforms, it would be beneficial if policymakers pay special attention to these points:

a) *Spectrum regulatory policy* will have an enabling role to play. E.g., the 5.9 GHz spectrum bandwidth is being considered globally for the intelligent transport system (ITS). It is also useful for vehicle-to-vehicle and vehicle-to-everything communication. Therefore, the timely release of the dedicated spectrum would be crucial, considering the automation and networked future of the automotive industry.

b) *Modularity* is one of the essential characteristics of a business ecosystem. It enhances coordination (Langlois, 2002) and is also valid for a circular economy business ecosystem (P5). Modularity promotes ecosystem coordination and provides an opportunity for incremental innovation benefits (Ethiraj et al., 2008; Jacobides et al., 2018). Modularisation and the outsourcing of bulky components compels the automotive tier 1 supplier to be near in geographical proximity to large OEMs. It is one of the key factors impacting a region's development (Bailey and De Propris, 2014). Also, the impact of the circular economy (refer table 6-21 and 6-21-1 above) shows that SMEs have more agility, and it is easier to manage the circular economy closed-loop regionally, as opposed to globally. However, most modular structures are difficult to recycle (P3). Therefore, policymakers need to allocate budgets for researching modular structure because modularisation may harm the environment while setting up regional or global closed-loop supply chains, which is good for a circular economy and regional development.

c) *Innovation and Complementarities*: The UK Industrial Strategy (HM Government, 2017) sharply focuses on innovation for creating a data-driven economy but does not discuss complementarities. Teece (1986, 1988, 2006, 2018b) has extensively discussed the complementary assets and capabilities required to commercialize an innovation successfully, and Chesbrough (2003) found them to be consistent for an open innovation too. Teece (ibid) explains the nature of complementary assets and distinguishes between generic, specialised, and co-specialised assets. Generic assets are general-purpose assets that do not need tailoring for an innovation. Specialised assets are those where there is unilateral dependence between innovation and complementary assets. Co-specialised assets are those for which there is mutual dependence. For example, the innovation of an autonomous circular car would require special repair facilities and skilled digital technicians for repairing autonomous cars, which manufacturers would own. Therefore, garages need to be specialists tied to the manufacturers, if they want to be in business. This research shows how complementary assets helped to achieve product heterogeneity for polymer recyclers and therefore, appropriate returns. According to Teece (1986, 1988, 2006, 2018b), ecosystem leaders decide the success of ecosystems.

From a regional development perspective, if a region's industrial policies ignore any complementarities arising out of innovation within a region, it is detrimental for that region's development. Innovation is often linked to new knowledge, which could be instrumental for developing location-based specialisms and capabilities, thereby reducing spatial imbalances (Bailey et al., 2018). A firm entering a nascent industry (Moeen, 2017 2494) requires complementary assets, technical capabilities, and integrative capabilities. Penrose (1959) may have referred to complementary assets when she contended that certain assets are fungible and possibly leveraged to support diversification. Complementary assets help a firm to differentiate itself from the competition.

6.7.6 Industrial-Data Governance policy

The production processes data is known as Industrial Data. As more and more automotive and IT firms digitalise their production processes to transform themselves into SMART factories, Industrial Data is going to grow (P33). Advanced automotive and IT firms are harnessing their Industrial Data for increasing raw material resources productivity. Industrial Data has developed as a product with revenue earning potential, and its production establishes the competitiveness of a region (Klepper and Sleeper, 2005; Gates, 2014; Clark and Sudharsan, 2019).

Similarly, firms are integrating Artificial Intelligence with smart production in a circular economy context for designing circular products and extracting the residual productive capacity of raw materials resources (Ghoreishi and Happonen, 2020).

Therefore, the Data Governance policy for Industrial Data is a big concern for both automotive and IT firms, more so after the Cambridge Analytica scandal. Robust legislation is absent for outlining the standards and norms of 'Industrial Data' governance and for deciding terms of access and transparency (Clark and Sudharsan, 2019). As a result, the policymakers need to be aware of this challenge and work towards addressing it.

Out of the several policy implications stemming out from tables 6-21 and 6-21-1 above, not all are directly related to this research study, because the circular economy or the augmented waste hierarchy is multidisciplinary, making policy implications widespread. Therefore, only a few policy implications that are directly linked to raw material resources and reducing their consumption are discussed above.

6.8 Conclusion

This chapter helps us to conclude on many issues that this research study has raised. As an example, it presents the plausible explanation of the circular economy's current understandings, its emergent characteristics that help us identify the type of a circular economy a firm practice. Studying the relevance of the VRIN factors in a circular economy business ecosystem identified a new emergent competitive advantage that takes care of the environment and society while securing future cash flows for the firm. As a result, which policies help to further the new emergent competitive advantage is also discussed. In the next chapter, seven, all analyses and discussions are brought together to answer the research questions.

Chapter 7 Conclusion

7.1 Introduction

The purpose of this chapter is twofold. Firstly, to bring all the findings, analyses, and discussions together in the previous Chapters five and six, for answering the research questions. Secondly, to present the contributions that this research study makes to the theoretical and practice of the circular economy. In so doing, it also lays down the limitations, and how future researchers can pick up on the threads that need further research to advance the circular economy field of scholarship.

Therefore, sub-section 7.2 discusses the conclusions. After that, sub-section 7.3 discusses the contributions that this research makes to the theory and practice of the circular economy. Sub-section 7.4 highlights the limitations of this research study; followed by avenues for future research in 7.5, to advance the circular economy field of scholarship.

7.2 Conclusion

The findings, analyses, and discussions in the previous Chapters five and six demonstrate that the circular economy's objective reality is knowable and describable. Following Bhaskar (1978), Collier (1994), Spash (2012, 2017, 2020), Mingers et al. (2013); Mingers (2014), this research study accepts that all the knowledge claims are fallible. Through its analyses and discussions, this research study can answer its research questions as follows.

Regarding answering the first research question, i.e., what best describes the current understanding, construction, and operationalisation of the circular economy by UK manufacturing firms and government agencies?

To this effect, this research study's endeavour to find the concept that best describes the circular economy that started in chapter 2 ends by comparing and contrasting the participants' responses, in chapters 5 and 6 and it, can conclude that an augmented waste hierarchy best describes the circular economy in the investigated UK manufacturing and government agencies. The circular economy is operationalised as the 4Rs (Reduce, reuse, recycle, recover) of the waste hierarchy aided by the latest technologies. Usually, the augmented waste hierarchy is heavily linked to advanced technologies such as Industry 4.0. The study found that closed-loop recycling helps in operationalising the circular economy more than any other process. Therefore, the participants construct a circular economy as closed-loop recycling to understand the circular economy, making it the next closest concept through which a circular economy can be understood. Closed-loop recycling has many variations, and it depends upon the intention of the firm's manager and corporate policy to decide the motive for following closed looping.

Differences in operationalising the circular economy (theory-practice contradictions) have led to the emergence of two circular economy types, i.e., a Standard Circular Economic and an Advanced Circular Economic. An Advanced Circular Economy is recognised by (a) radical innovation to alter the way of doing things completely (e.g., both in terms of business models and technology) for protecting the environment and creating economic surpluses and social value by consuming less raw materials resources (b) top management teams' genuine interest in reducing the consumption of raw material resources, reflected in the way costs and profit are calculated, with due weightage given to internalising external costs and creating wellbeing, (c) the firm's vision and mission hinge around *'I benefit if you benefit'* and the path, position and processes are designed around it, (d) managers can ascertain the extractive potential of wastes as well as that of raw material resources, and accordingly create their firm's raw material resources inventory, (e) managers give priority to the global impact of their local action, and (f) it enables multi-side markets to operate synchronically.

There are several paradoxes and dichotomies that arise due to theory-practice contradictions. That is, the research found gaps in 'Saying and Doing' by managers implementing/ practising the circular economy. To reduce such gaps, this research study identified an Intention-Practice-Outcome model (IPO model) for practising managers. The aim of the IPO model is to seamlessly integrate organisational intent with the inherent characteristics of the circular economy for delivering results across all the three dimensions (environment, economic and societal benefits) at the same time.

Regarding answering the second research question, how do firms manage waste? This study found that the investigated manufacturing firms and government agencies recognise that waste is the new resources. However, this recognition does not get translated into actions mostly by the manufacturing firms. It is because waste is still managed under the environmental policy or from a compliance perspective rather than resources. The government pushes recycling based on EU regulations, and recycling performance is evaluated on waste-based metrics. As a result, lighter items such as plastics get neglected, which creates enormous problems worldwide.

The study also found that the SMEs are more flexible and agile, hence more circular economy ready than the large MNCs. The Circular Economy is more achievable and manageable within regions rather than globally. It is so because creating a global circular economy involves many agencies, and the complexity in managing the expectations of all those involved is enormous compared to a regional circular economy. In a regional circular economy, the circle is small, and due to regional proximity, it is much easier to coordinate to manage. Therefore, circular economy growth is bottom-up rather than top-down. This approach is currently absent, hence the reason for its slow uptake, despite its immense popularity (which is inflated rather than real).

Regarding the third research question, i.e., the circular economy's impact on a firm's resource use and, in turn, achieving competitive advantage, this study found that the circular economy brings about a change to the existing practices within a firm, i.e., a different way of doing things. (monetizing radical and incremental innovation that helps in consuming less raw materials resources). It means a resource is valuable if it can be used multiple times and if it is substitutable. Also important is a manager's ability to ascertain the productive capacities of waste, which involves not only having organisational and individual capabilities such as sensing, seizing and reconfiguring', but also the skills to establish relationships with peers (both upstream and downstream), to extract the full potentials of waste and virgin resources. Therefore, to be circular economy-ready means that a firm needs to be ambidextrous, which is a dynamic capability (O'Reilly III and Tushman, 2008; Teece, 2019a). Thus, it allows us to conclude that a circular economy is one of the micro-foundations of dynamic capabilities (Khan et al.). The existing RBV-VRIN framework in its current shape and form is not yet proven suitable for a circular economy business from achieving a competitive advantage perspective.

The study identified an emergence of a new competitive advantage that is enabled by co-opetition and collaboration rather than competition. However, the circular economy markets can be characterised as high-velocity and turbulent having new forms of competition due to the influence of Industry 4.0 (see Tables 3-9, 3-13, and figure 3-1 in chapter 3 and Appendices 7 and 8 Table 7-3 and figure 7-1).

The new competitive advantage is not based upon economic gains alone, opening up the possibility of reducing the government's regulatory and compliance role for monitoring the reserves of raw material resources. It is so because it is in the firms' interest to consider environmental and societal benefits as it has become a norm when coopetition is central to market competition in a multi-sided business environment (see figure 3-1 and Appendix 7 and 8 figure 7-1 and table 7-3). The study also revealed a growing appetite for considering wellbeing and environmental protection to be a part of profit calculations. The Covid-19 pandemic and 5G technologies have shown how marginal production costs can be reduced further while making the same or more profits.

The study found that there is a lack of proper coordination between different Government agencies responsible for implementing the circular economy, which is largely due to the absence of an agreed common understanding of it.

Lessons to learn from the Welsh Government from its successful creation and implementation of the 'Well-being of Futures Generations Act 2050' and 'Globally Responsible Wales' is that the circular economy needs to move from the ambit of the natural raw material resources and be considered purely from an economics perspective.

The identified conclusions, paradoxes, and dichotomies could be addressed through policy instruments if these are specifically created, keeping the identified paradoxes and dichotomies in mind. Therefore, this study has suggested creating/inclusion of the following policies, which answers the research question four.

a) To establish a circular economy knowledge transfer network to promote a uniform understanding of the circular economy for both existing and prospective firms wishing to transition to an augmented waste hierarchy or a circular economy model.
b) To connect innovation in the waste hierarchy and Industry 4.0.
c) To create a supplementary raw material resources market for decoupling revenue growth and consumption of the natural raw materials.
d) To formulate urban mining and a natural capital policy, which is absent at the moment.
e) Creating an Industrial eco-system policy
f) Data governance policy for ensuring UK manufacturing is protected with more digitalization and automation of business processes.

The above conclusions help this study conclude that the circular economy is a paradigm having the powers to address the age-old tensions between the three dimensions - economic, environmental, and societal, all at the same time.

7.3 Research Contributions

This research study concludes that an augmented waste hierarchy is the most realistic description of a circular economy. This conclusion puts to rest the confusion arising from using various concepts to describe or understand a circular economy.

7.3.1 Implications for the managers' – *the practice perspectives*

The reality of a circular economy provides clarity to managers understanding and managing their firm's raw material resources. The simplicity of an augmented waste hierarchy equips managers better to deal with scarce raw material resources and their volatile prices. It also allows governments to promote a unified understanding of the circular economy, thereby aligning their efforts across all business sectors.

Managers are now clear that they need to harness the power of technology, design, and innovation to extract productive uses from raw material resources multiple times, in order to conserve resources. They also know the kind of resources to look for and the capabilities needed to operate in such a turbulent business ecosystem and to improve margins.

Identification of waste-as-resource and an augmented waste hierarchy as the reality of the circular economy brings clarity for business investors as they now know that through circular economy, they can 'get more returns with less investment'.

Managers are also able to understand and identify the subtle differences between the Standard and Advanced Circular Economy, recycling, closed-loop recycling, innovation, collaboration, and co-opetition activities.

The differentiation of the circular economy and the IPO model offers firms' senior management teams an opportunity to rethink and realign their organisational priorities. The redefined competitive advantage presents an option to senior management to choose between a conventional competitive advantage or an advanced emergent competitive advantage. The identification of transient competitive advantage and the role of complementary assets, and innovation, further help senior management to formulate strategies to prepare for capturing both transient and advanced emergent competitive advantage.

7.3.2 Implications for theory – the theoretical perspectives

This research study contributes extensively to the existing circular economy literature. The conclusions in Chapter 6, and their grouping earlier in this chapter's sub-section 7.2, are a testimony to the contributions delivered by this research study.

The research study informs the circular economy literature by concluding that the traditional waste hierarchy has undergone structural elaboration and transformation. Therefore, an augmented waste hierarchy is the most realistic description of the circular economy. It further shows that the conventional 4Rs (reduce, reuse, recycle and recover) have now become 9Rs. But there is little benefit from regressing the 'Re' imperatives infinitely.

The addition of environmental and societal dimensions represents the structurally elaborated waste hierarchy. Advanced technologies such as Industry 4.0 and 5G telecommunication technologies have transformed the new structurally developed waste hierarchy. As a result, all production and business processes have shifted to technology platforms, thereby opening multi-sided markets that have vast potential for reducing the consumption of resources. Radical and incremental innovation(s) are central to all these activities. Thus, this augmented waste hierarchy is the circular economy.

This assertion leads to the possibility of developing a circular economy meta-theory of competitive advantage[56]. To this end, this research has identified the emergence of a new competitive advantage where profit margin is increased by selling less, operationalised through new service-orientated business models.

This research study also clarifies impressions about the closed loop, by identifying it to be the next closest concept that best describes the circular economy. Thus far, the closed loop was confusing the understanding of a circular economy. However, if a firm practise closed-loop recycling it does not necessarily mean that it would be improving the environment and benefitting society.

In respect to an augmented waste hierarchy, 4Rs, or 9Rs activities that are innovative do not necessarily demonstrate the practice of a circular economy. They do not decouple revenue growth from the consumption of resources. Therefore, the regression of a conventional waste hierarchy evident in the literature does not improve or clarify the understanding of a circular economy significantly. It also does not benefit the practice of the circular economy.

This research study also identifies the underlying cause for the dichotomies and paradoxes found in the circular economy practice, which is the logic of profit. Chasing economic profit alone leads to neglecting the environmental and societal benefits by firms. It gives rise to two types of the circular economy - a Standard Circular Economy, and an Advanced Circular Economy, and the 'Intention-Practice-Outcome'(IPO) model.

A Standard Circular Economy is that in which a conventional or an augmented waste hierarchy is practised with the sole purpose of maximising revenues and taking care of shareholders'

[56]Circular economy meta-theory of competitive advantage could be based upon 'Asset specificity' and the new meanings of consumption in the circular economy context (see Appendix 8). "Asset specificity has a reference to the degree to which an asset can be redeployed to alternative uses and by alternative users *without the sacrifice of productive value*" (Williamson, 1975; Klein et al., 1978; Williamson, 1979). Governance based theories (GBTs) can also contribute to developing the circular economy theory of competitive advantage. As an example, the Agency theory can shed light on the design of corporate governance for circular businesses as well as emerging circular ecosystems. The transaction cost economics core tenet is asset specificity. It provides a theoretical explanation to the benefits accruing from 4R processes, i.e. it helps to explain the benefits arising from the first best and second-best use of resources. TCE also helps to explain value co-creation through collaboration in the circular economy context. The property right theory helps to form the theoretical base for reverse supply chain, giving insights into contracts and residual rights of an asset after its first best use, outside the resource owner's premises. Property rights theory paves the governance of property (resources/assets) rights, when resources are in a reverse supply chain allowing firms to claim for the services rendered by a resource at its end-of-life, even though the resource may not be in the active inventory of the firm. There is a possibility of developing a circular economy theory of competitive advantage by digging more into governance-based theories, which is an avenue for future research.

interests. It means that there are gaps between the organisation's intention, its practice, and therefore the outcome.

An Advanced Circular Economy is that in which there are no gaps between a firm's 'Saying and Doing.' That is, there are no gaps between an organisation's intention, its practices, and the outcome. All the business and production processes are well aligned. As a result, it generates economic as well as environmental and societal benefits.

SMEs are practising the Advanced form of the circular economy more, as compared to FTSE-listed Case companies, indicating that the change is emerging from the bottom up. Generalising, it would mean that the regions would drive the implementation of a circular economy more effectively. In turn, it would stimulate regions putting them on a dynamic sustainable growth trajectory.

A circular economy demonstrates that it brings about a change, and it is a micro-foundation of dynamic capabilities supporting the idea of a capability theory of the firm. The circular economy competitive advantage is emerging as a meta-theory of competitive advantage.

The VRIN characteristics of resources fall short in describing the characteristics of the resources required for achieving competitive advantage in a circular economy business ecosystem. The 'inimitability' and 'non-substitutability' characteristics do not hold any grounds in the context of a circular economy. As a result, the VRIN framework needs updating, hence, the RBV theory.

The used raw material resources or wastes have become new resources. The number of times a raw material resource can be recycled has become the new criteria for a valuable resource. In turn, it is dependent upon the managers' cognitive and technical capabilities to sense and seize such inherent opportunities that are present in raw materials resources.

A new competitive advantage is emerging, which supports the idea of redistribution of business benefits and sharing responsibilities among all agents and actors in society.

7.4 Limitations of this research study

This research study suffers from a few limitations, similar to any such endeavour. It has focused on the economic and competitive advantage aspect of waste. The other characteristics of a circular economy, such as a tool to implement the UN Sustainability Programmes, closed-loop recycling for consolidating supply-chain activities, the collaboration between firms for resources recoverability, the designing aspect, learning from biological systems, and energy flow aspects are not focused on with equal depth.

The researcher was not able to physically observe the recycling processes, routines, and resource flows followed in Case companies. It was mainly due to a firm's concern to protect its signature processes from the competition. The researcher's primary source was the interviewee's account, by which to access the reality of the circular economy. Most of the participants interviewed championed the cause of a circular economy in their respective roles, and are the real ambassadors of the circular economy and their views are representatives of their firm or industry. Still, anyone can argue that it is only an individual's perception of the circular economy.

Therefore, the author acknowledges, as a part of the Critical Realism tradition, that this knowledge of the reality of a circular economy is fallible. However, this does not mean that the data of this research study has been skewed in any manner whatsoever.

Also, the author has presented some elements of the findings in per cent terms for ease of explanation. It could lead to a perception that it is not representative of a qualitative comparative case study. The author has in way skewed data while comparing, contrasting Cases to identifying similarities, dissimilarities, and irregularities, or for uncovering the reality of the circular economy. The author had the option to calibrate a Likert Scale for explaining the number of participants that fall under an identified theme/ category. However, it would have further complicated the presentation of findings, so the author did not adopt it.

Similarly, there was a possibility of the researcher 'leading conversations', due to the heavy theoretical influence of waste and 4Rs on an understanding of the circular economy. The author minimised it to near zero by practising self-reflection and reflexivity after conducting each interview. As a result, the author can confirm that there is no possibility of a skewing of the results.

7.5 The avenues for future research

There is immense potential for future circular economy research stemming from this study.

Firstly, the 'Intention-Practice-Outcome' IPO model needs further research as it is similar to the 'the Plan-Do-Check-Act'- PDCA model or Deming's Cycle used for continuous improvement, related to Kaizen thinking (Walker et al., 2015; Rukijkanpanich and Pasuk, 2018).

Researching the IPO model is multidisciplinary. It involves different streams. For example, organizational intention involves psychology (cognition tension management, e-leadership, wise leadership)(Nonaka and Takeuchi, 2011; Li et al., 2016; Joseph et al., 2018); engineering (physical and biological sciences), and economics (social sciences) to name just a few.

Similarly, the ‘Practice’ in the IPO model involves operational management, continuous improvement, and supply chain management. ‘Outcomes’ are about strategizing and managing change.

Secondly, the circular economy has emerged as a meta-theory of competitive advantage. Therefore, the next logical step would be to develop a circular economy theory of competitive advantage. Many would argue that although the reality of a circular economy is an augmented waste hierarchy, it is an amalgam of pre-existing theories and concepts pulled together. The answer lies in the fact that a circular economy has been identified as a dynamic capability.

Therefore, it will be worth studying a circular economy in the light of governance-based theories, which include agency theory, transaction cost economics, and property rights theory. Also, RBV core intellectual antecedents, such as distinctive technological competencies (Selznick, 1957; Bolívar-Ramos et al., 2012), would further help in theorising the circular economy concept.

Thirdly, since this research finds SMEs to have implemented an Advanced Circular Economy, the inclusion of migration and social work research in future circular economy research, encompassing migrants, the homeless, and other outcasts, can help in regional transformation with inclusive growth studies (Bachtler et al., 2019).

While this research has served its purpose of identifying reality and bringing stability to an understanding of the circular economy, it has provoked new insights and new ways of working. The issues identified above are examples rather than an exhaustive list - all represent a springboard for further inquiry.

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Appendices

Appendix 1: The Three Phases of this Research Study.

This research study has been conducted in three phases. That is (a) the familiarisation phase; (b) the Tracking phase, and the third, (c) the Application phase.

Phase 1: It is the familiarisation phase. This phase is very crucial to make sense of the circular economy because it meant numerous things to different businesses. Therefore, the researcher, in order to familiarise himself used to attend regularly, most of the circular economy event conducted between 2011-2017. The need for familiarisation rose from the fact that between 2010-2014, there were very few pieces of literature emanating from the western economies on the circular economy. Most of the circular economy literature originated from China, and a good number of them were in Chinese.

Phase 2: The Tracking Phase. In this phase, the researcher gained insight from attending numerous of the circular economy events (see Appendix 2) that it inadvertently gets linked to Sustainability. Therefore, the next logical step for the researcher was to engage with the circular economy literature. In this phase, the researcher tracked the empirical traces of a circular economy in the historical roots of sustainable development and other details, which are presented in Chapter 2.

Phase 3: The Application Phase: During this phase, the researcher developed the conceptual framework to investigate a circular economy in the UK manufacturing sector to find its reality, including the concept that best describes a circular economy.

Appendix 2: The List of the Circular Economy Events Attended by the Author

Table 7-1: The Circular Economy events attended by the author

The Circular Economy Events attended by the Author during the Familiarisation Phase				
Name of the event	**Place**	**Date**	**Main theme**	**Learning**
1. Chatham House Briefing Event	Chatham House, London	01.03.2012	A Global Redesign? Shaping the Circular Economy	The Circular Economy seemed interesting
2. Schmidt-Ellen MacArthur Inaugural Public Lecture on the Circular Economy	Royal Institution of Great Britain, London	19.06.2013	Brought together the Founding fathers of the Circular Economy	A Circular Economy looked meaningful, hence created curiosity to know more
3. Workshop: Framework for a Circular Economy	HSSMI London	05.03.2014	The Circular Economy and Factories of the Future	Technology is the primary enabler for reducing the Cost of Production
4. Resource Efficiency & Waste Management	NEC Birmingham	16/18. September 2014	Circular Economy, Resource Efficiency & Waste	Resources are central to any business.
5. ESRC Business Model Seminar No.3: Business Model Prototyping and Testing	Prof. Jonathan Levie Strathclyde Business School. Glasgow	27.11. 2014	Business Model: Fast-tracking Competitive Advantage	Businesses need to think about Sustainability
6. EMF: Disruptive Innovation Festival	Online	07.11.2014	Disruptive Innovation	Innovation is central
7. Born to be Green: The Economics and Management of Green Start-Ups	University of Southampton	21-22nd .05 2015	Green Business	Use of Resources is central to any business.
8. Resourcing the Future - RWM	NEC Birmingham	15.09.2015	Exhibition	Resources are central
9. Industry 4.0 – Seminar by HSSMI	Liverpool	28.06.2016	Seminar/Workshop	Internet Technologies for Manufacturing.
10. Accelerating Innovation for a Circular Economy – Chatham House	Chatham House, London	12.07.2016	The Circular Economy approaches.	3D Printing/ Innovation/Consumption in a Circular Economy
11. Reuse, Remanufacture and Recycle- The Future of Circular Economy	House of Commons, The British Parliament	07.09.2017	Future of the Circular Economy	Recycling is key
12. Building the Future: Advanced Manufacturing in the UK	House of Commons, The British Parliament	14.12.2017	The IIoT and its Impact	The proliferation of technology in a circular economy discourse. Its role in reducing production costs.

Appendix 3: The Circular Economy Public Lecture: June 19, 2013.

Below (from left to right): Dominic Waughray (World Economic Forum), Professor Walter R. Stahel (Product Life Institute), Rachel Botsman (Author, Collaborative Consumption) & Ruben Van Doorn (Turntoo)

The Schmidt-MacArthur Lecture

Following the close of the first ever Circular Economy 100 Summit, the Schmidt-MacArthur Fellows, Mentors and the rest of the day's attendees were joined by a further 200 people for the **Schmidt-MacArthur Lecture** – the Summer School's apex of discussion and activity around the circular economy. **Wendy Schmidt, President of the Schmidt Family Foundation**, gave the opening address recalling the development of the collaboration with the Ellen MacArthur Foundation, after which she handed over to her husband, **Google Executive Chairman Eric Schmidt**. Eric touched on a broad range of topics throughout his talk, with the central fulcrum of his argument being how innovation and the internet can support and enable re-organisation of energy, resources & business.

Listen to a podcast of Eric Schmidt's keynote speech, with introduction from Foundation CEO Jamie Butterworth and information on the Fellowships from Wendy Schmidt. Listen now.

Thought-leader Panel Discussion

The evening culminated in a lively panel debate between six experts and thought-leaders, all of whom had also contributed throughout the day. McKinsey & Company's **Jeremy Oppenheim** made a robust economic case for a circular economy, which was complimented by impassioned responses from **William McDonough and Michael Braungart,** authors of the hugely influential best-seller Cradle to Cradle. The views of both these speakers highlighted the need for defining clear business values, whilst pointing out paradoxes in traditional 'do less' efforts employed by many companies and governments around the world. **Walter Stahel**, Founder and Director of the Product Life Institute and member of the Club of Rome, added vast knowledge of the performance economy in a segment that combined case examples with the discussion of broader economic change, such as shifting taxation away from labour. Biomimicry pioneer **Janine Benyus** added another angle to the panel focusing on what system and product design can learn from biology, specifically with regards to additive manufacturing; 'growing' products rather than extracting them from another material.

Ellen MacArthur reflected on the panel discussion and the rest of the day in her closing remarks, which focused on the process of learning that she underwent in setting up and developing the Foundation, and the continued importance of learning and collaboration in expanding our combined 'mapping' of a circular economy.

ELLEN MACARTHUR FOUNDATION
Rethink the future

THURSDAY APRIL 11, 2013
Schmidt-MacArthur Public Lecture - Wednesday, 19 June 2013

Eric Schmidt, Executive Chairman of Google to deliver keynote speech at the Schmidt-MacArthur Public Lecture

The Ellen MacArthur Foundation is delighted to announce that Eric Schmidt will provide the keynote speech at an evening of talks and discussion around the circular economy, on **Wednesday 19 June 2013**, at the Royal Institution of Great Britain, London. The talk will be followed by a panel discussion, chaired by Dominic Waughray of the World Economic Forum, during which leading thinkers will discuss the challenges and opportunities for businesses making the transition to a circular economy.

Panellists include: Dayna Baumeister (Biomimicry 3.8), Professor Michael Braungart (Erasmus University), William McDonough (McDonough Advisors), Jeremy Oppenheim (McKinsey & Company) and Professor Walter Stahel (Product Life Institute).

For its inaugural public lecture, the Schmidt -MacArthur fellowship programme will bring together the world's best experts and founding fathers of the circular economy for an evening of forward-looking, solutions-oriented debate. We are honoured to announce that Eric Schmidt, Executive Chairman of Google, will give the opening keynote speech, and that thinkers such as Michael Braungart and Bill McDonough (Cradle to Cradle) or Walter R. Stahel (Product Life Institute) will take part in the panel discussion. This first event, which marks the beginning of a 3-year collaboration between the Schmidt Family Foundation and the Ellen MacArthur Foundation, will take place at the prestigious Royal Institution of Great Britain - we could not have dreamt of a better kick-off!

Ellen MacArthur

Click here for further information and to book tickets.

eventbrite
Order #160331577

Schmidt-MacArthur Fellowship Public Lecture & Debate

Gallery £15.00

The Royal Institution of Great Britain, Albemarle Street, London W1S 4JL, United Kingdom

Wednesday, June 19, 2013 from 6:30 PM to 9:15 PM (BST)

Eventbrite Completed

Order Information

Order #160331577. Ordered by Anisuddin Gabbur on April 11, 2013 1:05 PM

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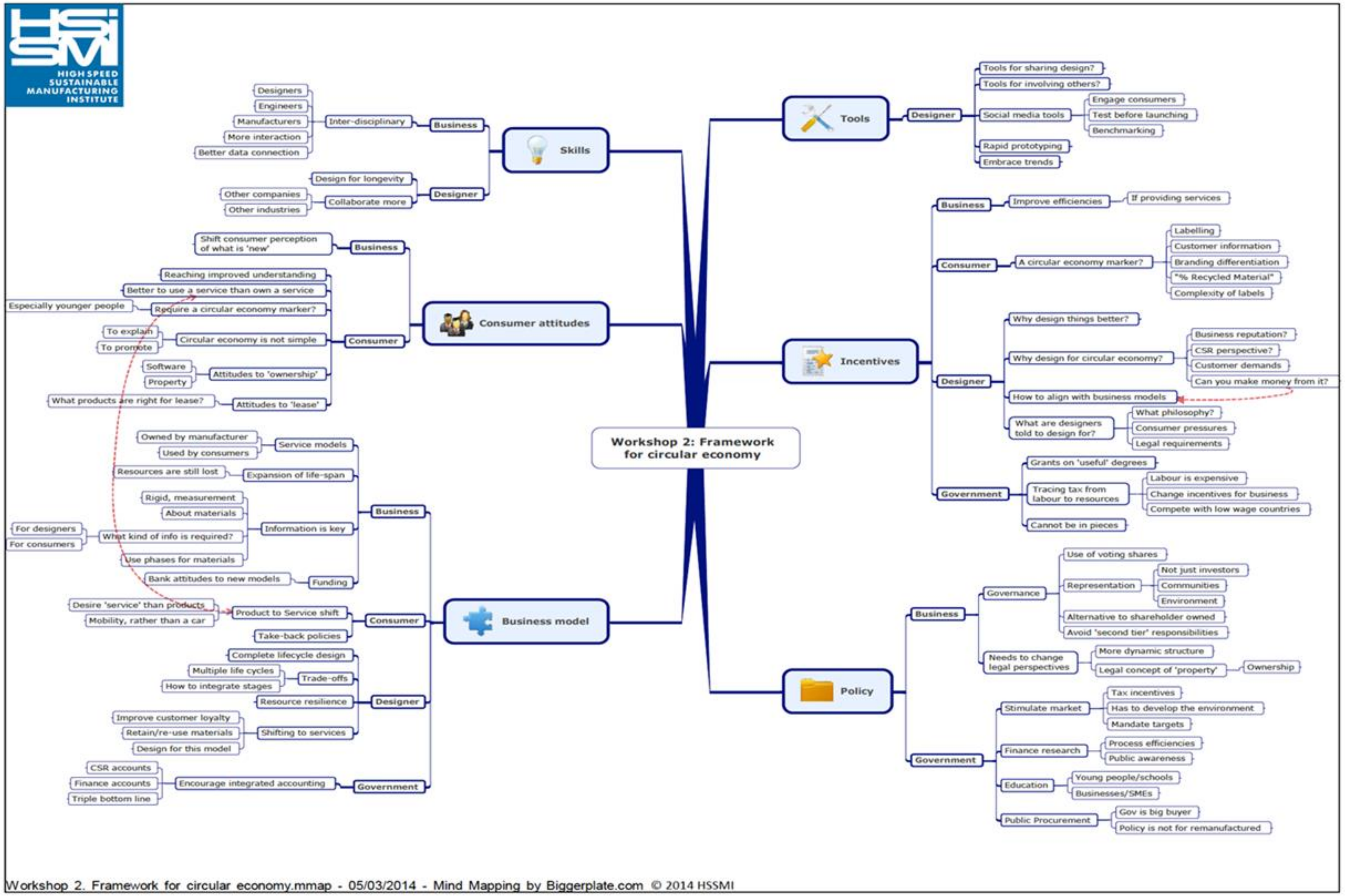
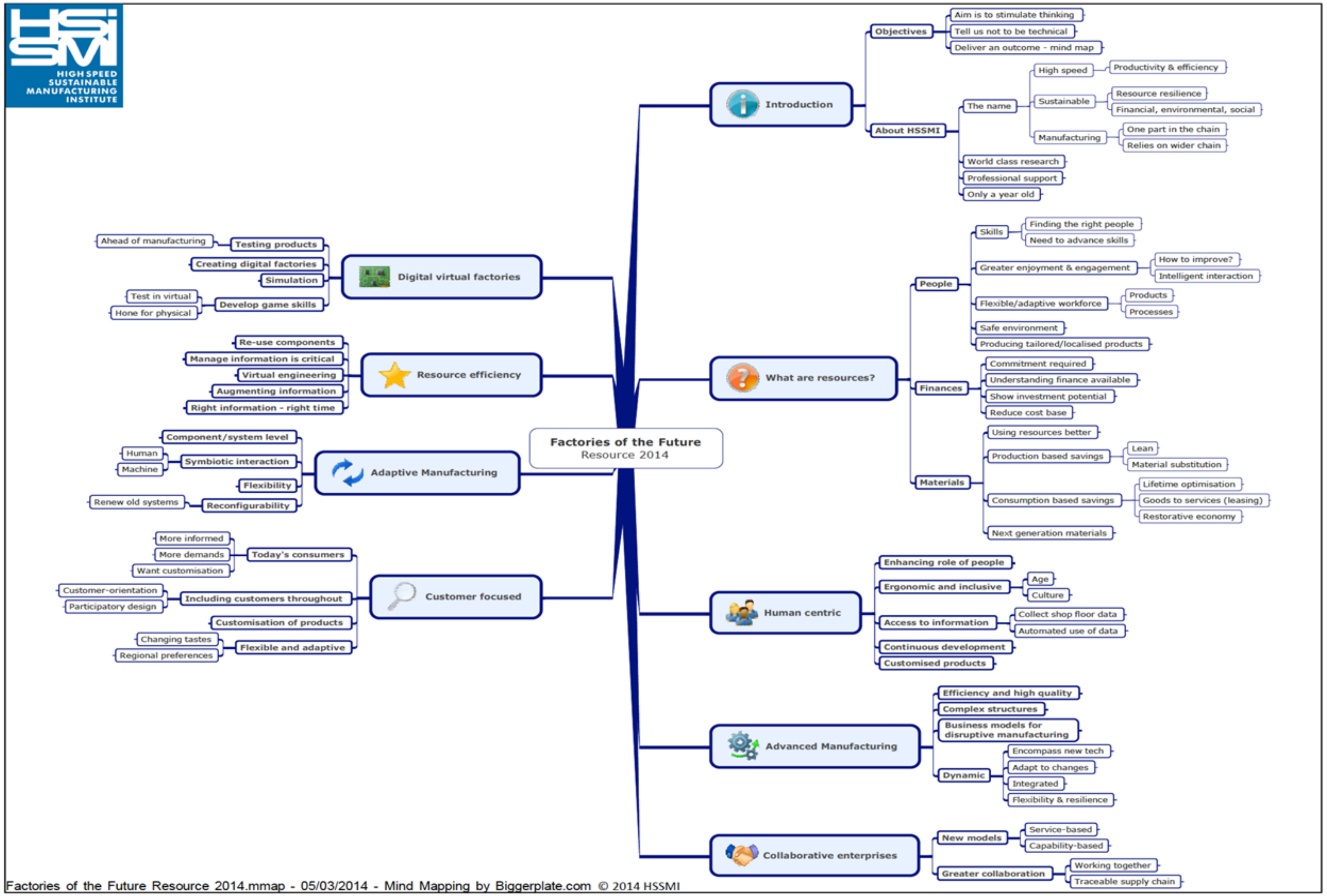
Agreement between Thought Leaders to promote the Circular Economy as an Economic/Business model

Appendix 4: Mind Map 1 of the circular economy



Appendix 5: Mind Map 2 of the circular economy



Appendix 6: The UK PhD Studies on the Circular Economy

Table 7-2: PhD Studies on the Circular Economy conducted in the UK HEA Sector: Source British Library EThOS as on 13.08.2019

No.	Author	Year	Contribution	Stream	Funded/ Non-funded
1	Baxter, Weston L. Imperial College, London	2017	Fills theoretical gaps in design research and practice-argues for a fundamental shift from the design of products to the design of possession in the context of a circular economy	Design Engineering	No information
2	Abubakar, F. H. University of Sheffield	2018	Analyses the circular economy concept, its drivers and barriers and suggests policy implications.	Management Studies	Funded
3	De Angelis, Roberta University of Exeter	2016	Contributes to sustainable business model literature, illustrates processes that help its development.	Management Studies	Funded
4	Charles, Rhys G. Swansea University	2018	Examines WEEE as a source for urban mining for embracing the circular economy, including how it benefits global sustainability.	Engineering	Funded
5	Blomsma, Fenna Imperial College, London	2016	How practitioners interpret the circular economy using a circular compass? That is design specially for the study.	Engineering-Environmental Policy	Funded
6	Ripanti, Eva Faja Cranfield University	2016	Develops a framework to design reverse logistics operations based on CE values to increase the efficiency and effectiveness of RL operations.	Aerospace, Transport and Manufacturing Dept.	Funded
7	Han, Sara Li-Chou Manchester Metropolitan University	2017	Studies the circular economy in UK Clothing and textiles industry, and provides a framework for transitioning to the circular fashion system.	Thesis under embargo until 05 April 2020	No information
8	Blissett, Robert University of Birmingham	2015	Contributes to the literature on multi-component utilisation of coal-fly-ash by illustrating five separate, yet related themes of exploitation thereby demonstrating the concept of the circular economy	EngD – School of Chemical Engineering – Engineering & Physical Sciences	Funded
9	Pringle, Tegan A Loughborough University	2017	Studies implementation of the circular approach in the leather industry. Identifies recycling solutions that help in the high-quality recovery of recycled materials.	Mechanical and Manufacturing Engineering	Funded
10	Whitton, Rachel Louise Cranfield University	2016	Algae reactors for wastewater treatment – identifies micro-algae contributing to wastewater treatment, thereby aligning to the circular economy aspirations.	EngD - School of Energy, Environment and Agrifood	Funded

Appendix 7: Juxtaposing *ReX* Taxonomy and Value Retention Options

If the 'ReX' taxonomy of Sihvonen and Ritola (2015) and 'value retention options - VROs' - of Reike et al. (2018) are juxtaposed, then we have a rich understanding of 'Re' processes relevant to the circular economy.

ReX taxonomy has 4Rs, starting with 'reduce' as a priority, similar to a waste hierarchy, while VRO clubs 'refuse, reduce and resell/ reuse' in its shortest loop, which is its starting pointing. The elaboration of 'Re' explained in both are similar. For example; 'Reduce as a priority' in ReX Taxonomy is identical to 'reduce' in the waste hierarchy in the EU directive (Directive-2008/98/EC), which is about preventive activities before a substance, material, or product becomes waste. At this stage, preventive activities are taken at each step in the lifecycle, and measures are adopted to avert the use of harmful substances in materials and products. They also take measures to avert the impact of generated waste and to lower the volume of waste generated (Lansink, 2014). In value retention terms, Reike et al. (2018) have expanded the priority 'reduce' to include not only 'reduce' alone but also 'refuse' and 'resell/ reuse' numbering them as R0, R1, R2 and R3, and terming this group as the 'shortest loop'.

Refuse R0 is used both in the context of consumer and producer. For consumers, it is about consuming less, i.e. to buy less or use less. Consuming less is for generating less waste (Black and Cherrier, 2010; Allwood et al., 2011), or consumers shifting towards a post-material lifestyle, e.g. refuse is often used in doing away with the plastic bag, i.e. rejecting the use of packaging waste (Clapp and Swanston, 2009). From the producer's context, R0 applies to refuse to use hazardous materials in production and to design out waste. Also reduce the use of any virgin materials (Bilitewski, 2012) - this is mainly at 'Concept and Design' stage. R0 from the producer's perspective matches with 'reduce as the priority' in ReX Taxonomy.

Reduce R1 in VRO is viewed in three ways; consumer-oriented, producer-oriented, and as a generic term. Reduce in generic terms is described as 'eliminat [ing] the production of waste rather than the disposal of waste itself after it has been created.' (Francis, 2003 p. 121). Den Hollander and Bakker (2012) have included sharing of products either through pooling or sequential use in the reducing category, as they think that sharing would reduce product manufacturing in the first instance. However, most of those activities that reduce reliance on materials, designing out waste, are included in this category, which is similar to ReX Taxonomy.

Reuse in ReX Taxonomy (ibid) comes in second priority in the waste hierarchy or Lansink ladder. Reuse is defined as “checking, cleaning or repairing recovery operations by which products or components reused” (Directive-2008/98/EC). In the Directive, interest is in the ‘Reuse’ of products and components instead of material reuse. Thierry et al. (1995) states that ReUSE strategy usually contains minor or more extensive upgrading operations intended to extend the life of the product (European Commission, 2014).

Resell/ Reuse: R2 is about resell, resale, and reuse. All of these are closely linked. It shows two sides of the market transactions needed to bring products back into the economic cycle. This concept is referred to from different perspectives, e.g. consumers, collectors, retailers, and producers. There is a strong preference for linking the ‘reuse’ concept to the ‘use’ phase of the product, produce, and use life cycle. Most scholars apply the concept only to reusing components, commonly termed as refurbishment or remanufacturing (King et al., 2006; Jayal et al., 2010). Generally, ‘reuse’ connotes a second consumer using the product, and the product hardly needs any adaptations and works as new (de Brito and Dekker, 2004); ‘with the same purpose’ (Ghisellini et al., 2016); and ‘without refurbishment’ (Silva et al., 2013). From a consumer perspective, this is buying a second-hand product that is as good as new, and was hardly in use, or used after some cleaning or minor adaptation.

*Resales or direct reuse i*n ReX Taxonomy falls under ‘reuse as a second priority’. It means the product’s functional performance may well stretch beyond ‘emotional wear-out time’. It allows the product to be used ‘as is’ for the original purpose, but in another type of market segment usually having lower price-levels. Reuse is also described as second-hand trading (Rose et al., 2002), or direct use (Thierry et al., 1995). In this context, e-bay, where consumers auction their products, has gained huge recognition. Literature suggests that minor repair and cleaning is common in reuse (García-Rodríguez et al., 2013). Also, direct reuse of unsold returns or products with damaged packaging belongs to this category, and the producer’s responsibility for re-using packaging (Romero and Molina, 2013).

Repair R3 in VRO (ibid) falls under the ‘small-loop, reuse category, while in ReX Imperative, it falls under ‘reuse as a second priority’. Repair for reuse, by the user or new consumer in a secondary market, involves restoring the product to a ‘working order’ (Thierry et al., 1995), ‘making it as good as new’(Srivastava, 2008); ‘bringing back to working order’ (Fernández and Kekäle, 2005); and ‘recreating its original function after [correcting] minor defects’(Stahel, 2006). Despite scholars trying to clarify the ‘repair’ term, confusion still exists, and the term is being used in different contexts, mostly denoting refurbishments, or repurposing. Reike et al. (2018) contends that repairing exhibits a distinction, i.e. it can be carried out by different actors at different locations.

The repair concept exhibits multisided markets (Gawer and Cusumano, 2002; Hagiu and Wright, 2015), because businesses send re-collected products to their repair centres (Thierry et al., 1995),or to a remanufacturer controlled centre, or to third party repair centres as part of a more extended maintenance plan (Den Hollander and Bakker, 2012; Den Hollander et al., 2017), or ad-hoc repairs.

Refurbish R4 in VRO falls under 'medium loop' and is being covered under 'reuse as a second priority' in ReX (ibid). Refurbishing demands more work than repair but less than remanufacture (Sihvonen and Ritola, 2015). It means, the overall structure of a multicomponent product remains intact, but many components are repaired or replaced, resulting in an overall upgrade of the product (de Brito and Dekker, 2004). The application of 'Refurbish' as a concept in CE literature is for buildings, aeroplanes, trains, mining shovels, or the engine or heavy-duty machinery (Thierry et al., 1995; Loomba and Nakashima, 2011). In refurbishing, quality is better in a product than repairing, as the idea is to achieve a specified quality and functional state for the refurbished components and parts, not the whole product. Through refurbishing all critical components are checked, fixed or replaced as needed (Thierry et al., 1995). Such subtle differences help to configure business models that address the inherent needs of the customers, although willingness to pay for such quality may remain low due to the customer's perception.

Remanufacture R5 in VROs falls under medium loop while it is considered part of 'reuse'. Remanufacturing applies where the full structure of a multi-component product gets disassembled, checked, cleaned and if necessary is replaced or repaired in an industrial process (Lieder and Rashid, 2016). Remanufacturing is in the pre-use phase in the waste directive (European Commission, 2014). The processes involved in remanufacturing differ from product to product and its complexity. Remanufacturing is seen as restoration activity, and thus influences reverse logistics. According to Rose et al. (2002), the processes involves inspection, test, full disassembly, part replacement or refurbish, clean, and then reassembly and re-inspection. The core identity of the product is assumed to remain the same (Sundin and Bras, 2005). Cannibalization is the term usually used when reusable parts are injected back into the manufacturing process (Thierry et al., 1995).

Resynthesize appears in ReX (ibid) but not in VRO (ibid). Resynthesize is about components using components distinctly for other purposes than planned. Woo Kang et al. (2013) consider resynthesizing on a par with disposal, reuse, remanufacture and recycle. The configuration and function of current products and assemblies is synthesized across multiple domains towards creating a new artefact differing from the original purposes. Resynthesizing necessitates disassembly and reconfiguration of components from different products to put it into a new application.

*Repurpose (R*6) in ReX and VRO is about using the same products for different purposes and has been suggested to reduce waste by Ortiz et al. (2010). An excellent example is 'smartphones'; and used automobiles used 'as is'. Reike et al. (2018) informs that repurpose is not used much in CE literature and only three articles referred to the 'repurpose' term (Sihvonen and Ritola, 2015). This term is linked to 'rethink' (Wenbo, 2011), while Stahel (2006) gives examples of unemployed workers using discarded goods or components to transform useful products; examples being, transforming defective microchips into jewellery, glass bottles into mugs, or textiles waste into quilts.

The long loops in VRO include recycling materials (R7), recover (R8) and re-mine (R9) while ReX considers recycling as a standalone operation falling in the third position as in the waste hierarchy.

Recycling (R7) defined as '*any recovery operations by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes'* (Directive-2008/98/EC, 2008). However, recycling is at the bottom of the waste hierarchy. They are mostly practised, but are confusing (Reike et al., 2018 p. 256). King et al. (2006) describe recycling as a process in which the materials are either restored to their original form or downgraded further for purity, thereby using them for other purposes. Recycling processes are understood to include sorting, separating, and disassembly (Kriwet et al., 1995), shredding, and melting. Other processes to capture (nearly) pure material (Graedel et al., 2011), also include streams of post-consumer products or post-producer waste streams using high-end technological equipment (Yan and Feng, 2014). Automatic and manual disassembly also forms part of recycling, in order to separate valuable material fractions and hazardous materials or contaminants (Rose et al., 2002). For Ayres and Ayres (1996), recycling is about any form of avoiding the use of virgin mining materials or resources. Stahel (2006) identifies that recycling also takes place in a business-to-business environment, when production waste from end producers or component producers is being recycled, described as primary recycling. It is advantageous because there is no contamination of materials at this stage as opposed to secondary recycling, where municipal waste collectors collect use end-of-life products.

Recover R8 in VRO (ibid) is the fourth priority in ReX (ibid) and waste hierarchy (ibid). Recovery has reuse and recycle as sub-categories, according to the waste directive (ref. figure 4), whereas 'other recovery' in figure 4 contains energy or metal, and metal compound recovery processes, amongst others (Directive-2008/98/EC, 2008).

Recovery is often found (a) mixed with collecting used products at the end-of-life, (b) it is found in the second position in 3Rs ranking(Wang and Hsu, 2010), and (c) found to be discussed commonly in reverse logistics literature (de Brito and Dekker, 2004). It may also mean the extraction of elements from end-of-life composites (Stahel, 2006), and according to Allwood (2014), the word ‘recover’ is found to be used concerning the ‘energy recovery’ from waste streams. During the 1990s recovery was found to be linked with ‘added-value’ and metal recovery, according to Fleischmann et al. (1997). Added-value recovery includes repair and remanufacturing of products and components, while material recovery seeks to retrieve valuable and hazardous materials during the after-use phase by Ilgin and Gupta (2010), cited by Sihvonen and Ritola (2015 p. 642).

Re-mine R9 is a VRO (ibid) but not part of ReX (ibid) typology. Reike et al. (2018) contends the re-mining is the most ignored in operationalising CE. The other term for re-mine’ is cannibalization, which probably stems from ‘scavenging’ where people make a living by collecting rubbish and then separating valuable items from it, in developing countries. Focusing on the most valuable part is known cannibalization (Thierry et al., 1995; Fleischmann et al., 1997). The terms are also in use to mean retrieval of selective parts (de Brito and Dekker, 2004).

Re-servitization is another value retention option that has not been featured as part of the ‘reuse’ option by most scholars in this domain, despite it being highly inter-related to ‘reuse’. However, recent CE articles stress the inclusion of ‘re-servitization’ as part of rethinking ‘product-service-systems (PSS)’, making it part of CE business models (Reike et al., 2018 p. 257).

All of the above categorisation (VRO: R0-R9 and ReX Taxonomy) seems to be underpinned by eco-design’s ten golden rules, laid out in Table 2-1. These golden rules were set to fulfil the pedagogic need in the eco-design course, and thorough synthesis of several environmental designs used in manufacturing companies and academia.

Emergence of new market structures: While the different categorisation has expanded the waste hierarchy, it has also led to the emergence of a new market structure.

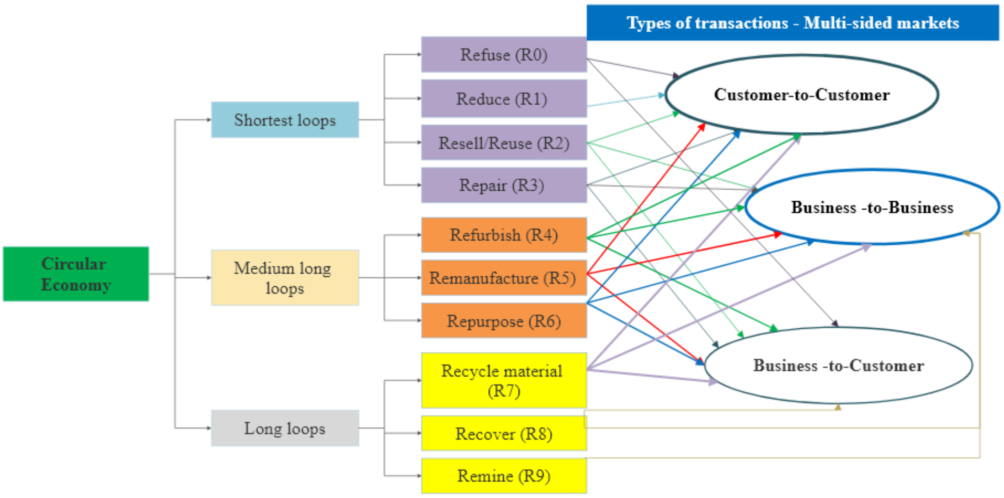


Figure 7-1: New market structures emerging from 'Re' imperatives. Source: Author informed by Reike et al. (2018)

In order to realise the value retention from used resources, any one out of the three types of transactions are needed. These transactions are (a) customer to customer (C2C), (b) business-to-customer (B2C), and (c) business-to-business (B2B). Each ‘Re’ imperative opens up unique market structures for the firms, based on the type of transactions a firm chooses to engage. For example, from figure 10, we can see that reuse opens two types of transactions, i.e. business-to-customers and business-to business to put the used resources back into the economy. The firms involved in these transactions are mining companies, producers, retailers, consumers, collectors, waste management processors, second life retailing, and consumers. It represents two-sided markets (Rochet and Tirole, 2006). Similarly, each R involves a minimum two-sided markets and in some cases such as refurbishing (R4), remanufacturing (R5), repurposing (R6), recycling (R7), involves all three types of transactions. These multi-sided markets involve multiple stakeholders, depicting the old strategic factors markets of Barney (Barney, 1986, 2018). It also represents an ecosystem offering value creation through collaboration and co-opetition, and an entirely different set of rules for competitive advantage (Adner and Kapoor, 2010; Gawer and Cusumano, 2013; Adner and Kapoor, 2016a, 2016b; Adner, 2017; Jacobides et al., 2018; Elmquist et al., 2019).

Innovation and creativity underpin CE operations. For example, innovation and creativity are required for R3, R4, R5, R6, R7 and R8 processes, not only in relation to product development but also to create and capture value from used resources (Schumpeter, 1934, 1943; Penrose, 1959; Teece, 2007, 2010, 2014a, b, 2019a, b) The competitive landscape thrives on orchestration, collaboration and co-opetition (Brandenburger and Nalebuff, 1996; Elkington, 1998; Akpinar and Vincze, 2016; Seran et al., 2016; Cozzolino and Rothaermel, 2018; Cozzolino et al., 2018; Pitelis and Teece, 2018).

Appendix 8: New meanings of Consumption in the Circular Economy

Camacho-Otero et al. (2018) reviewed 111 articles and captured new meanings of consumption presented in Table 8-3 below.

Table 7-3: New meanings of Consumption in the circular economy. Source: Camacho-Otero et al. (2018 p. 14)

Aspect	Description	Authors
Anonymity	In the circular economy, the consumption becomes anonymous because people do not own products, they merely use them. The identity potential offered by goods dissolves; people might not be able to define themselves by the products they own any more.	(Park and Armstrong, 2017); (Bardhi and Eckhardt, 2012); (Philip et al., 2015)
Connected Consumption	New relationships between consumers and companies develop, resulting in deeper forms of engagement and involvement. The idea of a community is also relevant in the circular economy. Reciprocity, sociability, and interaction become key aspects that are realized through networks and sharing activities. Such settings facilitate the establishment of institutions that can enforce engagement and trigger commitment by participants. Usually, such characteristics arise from initiatives that come from the bottom up, rather than top-down.	(Huber, 2017); (Welch et al., 2017); (Philip et al., 2015); (Mylan et al., 2016); (Albinsson and Yasanthi Perera, 2012)
Multiplicity of values	Although circularity is based on functionality, solutions cannot only rely on their utility value, they need to create symbolic value as well. Thus, consumption in the circular economy, as in the linear economy, needs to address several values at the same time. Two relevant aspects that become valuable in the circular economy are frugality and wellbeing. Circular solutions also consider these aspects.	(Mylan et al., 2016); (Welch et al., 2017); (Santamaria et al., 2016)
Political Consumerism	Consumers perceive circular solutions as a form of rebellion against mainstream consumption and engaging with them is expected to reflect a certain political stance. In the past, material consumption was perceived as a status symbol. However, dematerialized consumption becomes the norm in the circular economy.	(Park and Armstrong, 2017); (Bardhi and Eckhardt, 2012)
Uncertainty	Since in the circular economy, products only move temporarily from producers to consumers and then return to continue their journey with other consumers, issues of trust, risk and control arise. Thus, efforts to formalize such ‘liquid relationships’ are fundamental to reassure both parties in the transaction. Knowledge and information are also expected to address such concerns.	(Briceno and Stagl, 2006); (Park and Armstrong, 2017); (Bardhi and Eckhardt, 2012); (Welch et al., 2017)

The anonymity aspect (Albinsson and Yasanthi Perera, 2012; Bardhi and Eckhardt, 2012; Philip et al., 2015; Park and Armstrong, 2017) of collaborative consumption occurs in the context of use whether it is private or public. Or, where interaction between consumers accessing the same product or services does not happen, e.g. car sharing or hotels - this is also being referred as ‘society of strangers’ by Simmel (1950) and recently ‘collaborative commons’ by Botsman and Rogers (2010) and Rifkin (2014).

Connected consumption (Mylan et al., 2016; Huber, 2017; Welch et al., 2017) is linked to ‘Really-really free markets’, a radical movement to oppose the capitalist economic model (Albinsson and Yasanthi Perera, 2012). This has become mainstream, fuelled by the economic downturn, the sustainability movement, and facilitated by the internet (Schor, 2017). It brings communities together based on the Aristotelian notion of interdependence and reciprocity between diverse individuals (Selzinck, 1992).

Multiplicity of value (Mylan, 2015; Mylan et al., 2016; Santamaria et al., 2016; Welch et al., 2017) is about other than economic value. It includes ‘social value’ generated through the process of collaborative consumption, and value generated alongside resource consumption in the domestic sphere, extending beyond economic or material calculations, including necessities of care, enjoyment, maintenance of traditions, and connectedness with past personal histories. Social values also include wellbeing and happiness, and increasing consumption, do not secure people's wellbeing and happiness, in fact it undermines them (Kasser et al., 2013).

Political consumerism 'represents the use of market action as an area of politics, and consumer choice as a political tool' (Micheletti et al., 2004; Bardhi and Eckhardt, 2012 p. 85; Park and Armstrong, 2017).Consumers exercise their choice to use the mode of consumption, i.e. ownership or access. They use mode of consumption as a strategy to patronise their ideological interests in society, business, and government, e.g. collaborating to access could be a strategy to patronise an environmentally sustainable or anti-market consumption alternative.

Collaborative consumption is characterized by Ertz et al. (2016 p. 5) as 'activities that involve consumers as both providers and obtainer of a given resource'. More specifically:

(a) 'The obtainer' is the consumer, who seeks to obtain a resource or service that is provided by another consumer, i.e., provider, or indirectly through the mediation of an organization known as the 'mediator' (for profit or non-profit). 'Obtainment' entails second-hand purchase, free receiving, swapping, accessing a resource for free or for a compensation (excluding conventional consumption access), reconditioned/ refurbished consumption, and to a lesser extent, recycled content consumption.

(b) 'The provider' is the consumer, who provides a specific resource or service either directly, to a consumer i.e. obtainer, or, indirectly through a 'mediator'. 'Provision' involves reselling, giving for free, swapping, providing access free of charge or in exchange for a compensation, recycling, or trading with an organization.

Collaborative consumption is also conceived as a 'resource circulation system' that involves different levels of collaboration, which can be categorized as (a) pure collaboration (P2P: peer-to-peer); (b) sourcing collaboration (P2O: peer-to-organization); and (c) trading collaboration (O2P: organization-to-peer).

Boulding (1953, 1966) argued that high consumption (both conventional and collaborative) should not be encouraged as ultimately it is depleting the natural resource reserves, and the notion that high consumption and high production (i.e. gross domestic product GDP) leads to growth is faulty. Boulding (ibid) argued that growth should be measured in terms of the condition of natural resources, i.e. how much natural resources are saved or ploughed back into the system, and the state of human bodies and minds, i.e. individuals' wellbeing. He suggested GNP (gross national product) as a measure of growth instead of GDP. GNP is an estimated value of the total worth of production and services, by citizens of a country, on its land or on foreign land, calculated on a yearly basis). Boulding (1966 p.8) suggested that whilst calculating GNP, it will be beneficial if there is a mechanism to bifurcate that part of GNP that is derived from exhaustible and reproducible resources, including that part of consumption that represents effluents, and the part that goes back into the productive system again - this is consistent with the 'Re' imperatives discussed above. The OECD (2013a p. 26) in its report has also mentioned that there is growing concern regarding the adequacy of traditional GDP as it does not capture people's current and future living conditions that 'sustainability development goal no. 3 – SDG:3' strives to achieve (UN, 2015). GDP is criticised on three main grounds: (a) GDP on its own terms is a faulty measure, (b) it takes no account of sustainability and durability, and (c) progress and development can be better gauged by other metrics.

The role of man as an individual in the economic system has been recognised by both Bertalanffy (1952) and Boulding (1966); (Heilbronner, 1975). Both believed that 'Man' should be respected and given freedom. They both argued that more than the laws that govern society, the main tenet is 'the man himself'. Therefore, understanding the mind of an individual is significantly important to economic growth. Although, the concept of wellbeing is widely used, there is an absence of a commonly-agreed definition. Mostly, terms such as quality of life, happiness, and life satisfaction are used to denote wellbeing, and used interchangeably (OECD, 2013a). Wellbeing is defined as 'a dynamic state, in which the individual is able to develop their potential, work productively, and creatively, build strong and positive relationships with others, and contribute to their community. It is enhanced when an individual is able to fulfil their personal and social goals and achieve a sense of purpose in society.' (Thompson and Marks, 2008; OECD, 2013a, b, c). Stiglitz et al. (2009) argue that the time is ripe to shift the measurement system from measuring economic production and consumption to measuring people's wellbeing. Also, measures of wellbeing should be put in the context of sustainability. Most possibly, in a bid to out-do the sustainability concept, the EMF, the frontrunner in promoting the CE concept, has added wellbeing as part of the circular economy. In 1980s Amartya Sen distinguished between 'commodities', which show up in GDP, and 'capabilities', which do not. Joseph Stiglitz came up with 'Green GDP'. Green GDP was halted both in the US and China for political reasons. "The Human Development Index", to include sustainability and income distribution, was developed by Amartya Sen and Mahbub-ul-Haq (Fox, 2012).

Appendix 9: Research Cover Letter

03 April 2017

Dear Sir or Madam:

Re: PhD project on the circular economy: request for interviews

Thank you for showing interest to be a part of this research project and help us in piloting interviews at stage-1 of this research study. We provide here, a brief overview of the project, i.e. its aim, objectives and other details that will enable you to understand the purpose and relevance of this work that we are undertaking. Anis Gabbur conducts this PhD research study under the supervision of Prof David Bailey and Dr Breno Nunes.

This research aims to critically explore the real understanding and meaning of the circular economy in totality for UK's manufacturing firms and policymakers. It means that the research study will explore the underlying issues, which gets linked to the circular economy phenomenon. That, in turn, will help to understand the circular economy's distinctiveness and generative mechanisms.

The objectives are to (a) explore what the distinctive and competitive nature of the circular economy is; (b) investigate how the economic, societal and environmental benefits of the circular economy impacts on the resources and capabilities of UK manufacturing firms; (c) provide a methodology on how UK manufacturing firms can adopt circular processes; and (d) consider how the role of government affects the transformation to a circular economy.

The motivation of this research comes from: (a) the issues of resource scarcity and high resource price volatility that UK manufacturing firms have to deal with, on a day-to-day basis currently; (b) the opportunities that sustainable development goals opens up for business if businesses are able to understand economic, social and environmental challenges are future value drivers. The latter includes how manufacturing firms obtain, use and reuse those resources that flow and circulate within the economy since resources are the lifeblood of manufacturing firms and account for 40% of manufacturers' cost. There is a tendency in the UK to consider recycling as a panacea, and environmental concerns have typically driven the focus on resources. However, the solutions are likely to be more complicated than that.

Therefore, the experimental design of this research study is composed of: (a) an overview and analysis of resource-related initiatives in the company and (b) personal interviews across different sectors of the manufacturing industry. In order to accomplish these activities, we consider each personal interview will not take more than forty-five minutes.

The participating company will benefit in a variety of ways for example: (a) the key findings will be shared with the participating company, which will help the company to have an improved understanding of the circular economy phenomenon; (b) it will offer a better understanding of the novel resource – 'waste'; (c) help in the sharing of best practices, and (d) offer better awareness of forthcoming legislation relating to waste/resources. It will also help firms' managers to have a better understanding of the new meaning of competitive advantage and profit. We hope that managers will have a better idea of the skills and competencies that will be required to operate and compete in a circular economic environment.

We wish to stress here that we follow the Ethics code of conduct as prescribed by the Data Protection Act 1998, and Aston Data Protection Policy very strictly. In case we plan to publish any of the findings relating to your company, we will first seek your approval.

We are flexible and happy to work around your availability to carry out the above-proposed activities and look forward to your valuable feedback.

After this piloting stage-1, we shall be progressing to stage-2 for full-fledged personal interviews, where we would seek your help again to access your member companies, please.

Please feel free to ask should you require further information/clarification(s) regarding the research study. We shall be too happy to address any queries of yours.

Thank you very much for your time.

Yours Sincerely,

Anisuddin Gabbur
PhD Researcher

Aston University

Appendix 10: Research Consent Form

Consent form

Research Title:

The dynamics of sustainable strategic growth:
Exploring the circular economy paradigm in the UK

Name, position and contact address of the researcher:

Anisuddin Gabbur
2nd Year PhD Student,
Aston Business School
Room no: 1106, 11th Floor,
South Wing, Main Building, Aston Triangle
Aston University
Birmingham B4 7ET

Please initial in the box

I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask questions.	
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason.	
I agree to take part in the above study.	
I agree that my data gathered in this study may be stored (after it has been anonymised) in a specialist data centre and may be used for future research.	

Please tick box

	Yes	No
I agree with the interview/focus group/consultation being audio recorded		
I agree with the interview/focus group/consultation being video recorded		
I agree with the use of anonymised quotes in publications		

Name of Participant ____________ Date ____________ Signature ____________

Principal Investigator: Anisuddin Gabbur
Supervisors: Prof David Bailey & Dr Breno Nunes
Aston Business School

Appendix 11: Information Sheet for the participants

Information Sheet

Research Title:

The dynamics of sustainable strategic growth:
Exploring the circular economy paradigm in the UK

Dear participant,

Thank you for showing interest to be a part of this research project. We provide here a brief overview of the project - its aim, objectives and proposed schedule to enable you to understand the purpose of this research, and what does it entail. We request you to kindly read the FAQs (frequently asked questions) outlined here in order to acquaint yourself with the various issues that you may have in mind. In case your question does not appear in FAQs, please feel free to write to the principal investigator whose email at the end of this information sheet.

The participation in this research project is voluntary, and participants are permitted to withdraw from this research at any time if they wish.

What is the purpose of this study?

This PhD research project aim is to critically explore the real meaning and understanding of the circular economy phenomenon in 'totality'. It essentially means that the research study shall explore the underlying issues that affect the circular economy. The interview process is likely to run for about four months, and the study is likely to end in September 2018.

Why have I been invited to participate?

The study is trying to understand how firms handle their resources, especially critical resources and its scrap (surplus) that gets generated during the production process, including the discarded resource – waste. Therefore, the principal investigator felt that it is appropriate to interview the persons who directly or indirectly deal with resources' management. Hence, we chose you for the study.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you shall be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will happen if I take part?

If you decide to take part, we shall ask you to have a one-to-one conversation with the principal investigator (PI). The PI will seek to understand your views on specific issues through posing simple questions to you that involves your day-to-day functioning. Interviews will last from about 45 minutes on average to about an hour.

What are the possible benefits to you of taking part?

The benefits of taking part in this study are two-fold. Firstly, participation will help you to clear your understanding of the circular economy phenomenon, which may help you in your day-to-day functions in your role. Secondly, we shall be sharing the key findings of the research with you so that you will benefit from industry best practices and insights thereof. Thirdly, you will be informed well in advance of the next opportunities or threats – for example, and you will come to know of any legislative changes that are affecting resources' and its wastes', which in turn may give you first movers' advantage.

Will, what I say in this study be kept confidential?

All information that will be collected from you through one-to-one interview will be recorded and shall be kept in strict confidence (subject to legal limitations). The names of the participants will be anonymised, and data will be subject to a high level of privacy. The names of the participants will be assigned a code, and we shall be using that at all times during collection, storage and publication of research material. All the data will be stored in electronic form and kept in external SSD drives under lock and key. The access to the locker shall only be with the principal investigator. Data Protection Act 1998, and Aston University Data Protection Policy followed is very strict, and data generated during the study will be kept in paper and electronic form for ten years after the completion of the research project. We shall first seek your approval. In case we plan to publish any of the findings relating to your company.

What should I do if I want to take part?

If you want to take part, please show your interest to the principal investigator by emailing on gabbura@aston.ac.uk or calling on: 07715 638 686/0121 426 1048.

What will happen to the results of the research study?

We shall publish the key findings/ results of this research study in the form of a PhD Thesis, which will be available both electronically and in hardbound copies at the British Library and Aston University library. Some portion of the thesis will also appear in established and well-known refereed Journals as articles. If you wish to have a dissertation copy, kindly get in touch with the principal investigator via email as mentioned earlier, giving your full name and contact details.

Who has reviewed the study?

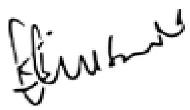
The Aston University Research Ethics Committee has approved the research.

Contact for further information

In case you need any further information/clarification, please get in touch with Anis Gabbur at gabbura@aston.ac.uk In case you have any concerns about how the researcher conducts this study, please contact the Secretary of the Aston Business School Research Ethics Committee on r.hancock@aston.ac.uk.

We thank you once again for your patience and look forward to speaking to you soon.

Sincerely yours



Anisuddin Gabbur

Appendix 12: Semi Structured interview questions

Before we begin the interview (or talking) about my research, I would like to state (or confirm) that our conversation would be confidential. Your name and your company's name will be anonymized as I must follow the confidentiality guidelines as set out in the Data Protection Act of 1998 and Aston University's Ethical Policy Guidelines. The data will be kept for at least four to five years so that if there is any query arising from the research, the original interview will be available for checking purposes. My two supervisors and I will have access to the information that you will provide me.

I will send you the transcript of this conversation for you to amend and approve. Only when you have checked the authenticity of the conversation and approved it, would it become part of the data. In any publication arising from the research, if a quotation from you were used, your prior written permission would be required.

Is it possible for you to tell me more about your role in XXX?

A. CURRENT UNDERSTANDING OF THE CIRCULAR ECONOMY, ENABLERS AND BARRIERS

IP1: How would you describe the notion of a circular economy?

IP2: In your opinion, what does the circular economy mean to automotive manufacturers?

Sub Question: In your view; is there a shared understanding of the meaning of the circular economy within your company?

IP3: In your opinion, what are the components of a circular economy?

IP4: Do you see any barriers in implementing CE?

IP5: And are there any enablers that help in implementation CE?

IP6: In your opinion, how does sustainability differ from the circular economy?

IP7: What is your notion of profit in the context of the circular economy?

IP8: What kind of skills and competencies you look for when you are recruiting in your design department?

B. EFFECTIVENESS OF WASTE MANAGEMENT POLICY & CONSERVATION OF RESOURCES

IP9: In your opinion, what constitutes waste?

IP10: And how is waste managed in Nissan?

IP11: What are critical resources for your business?

IP12: How do you mitigate the risk of short supply of your critical resources?

IP13: How do you maximize the value derived from your critical resources?

IP14: Can you tell me about remanufacturing?

IP15: And how could it deliver higher economic value and competitiveness?

IP16: Assuming, if you were to improve the waste management process, what would be your first steps?

C. COMPONENTS OF THE FRAMEWORK

IP17: What would be your recommendation to improve waste management policy? What would be the first steps that you would advise your clients?

IP18: In your experience, does the structure of a firm being an enabler or barrier for better waste management?

IP19: If you were to devise a system that would help you to change to a circular economy, what would be the core elements of this system?

IP20: In your opinion, what is the role of regulation for the process of transition to a circular economy?

IP21: If you could have a system that would help you to change to a circular economy, what would be the core elements of this system?

IP22: If you were to devise a route map to a circular economy, what process would you follow?

Do you think you have any more relevant information to share?

At the end of the interview: Thank you.

Finally, will you be able to give me a few more minutes if a brief follow-up interview is needed?

Appendix 13: The Coding process - Comparison of nodes for constructing the main themes

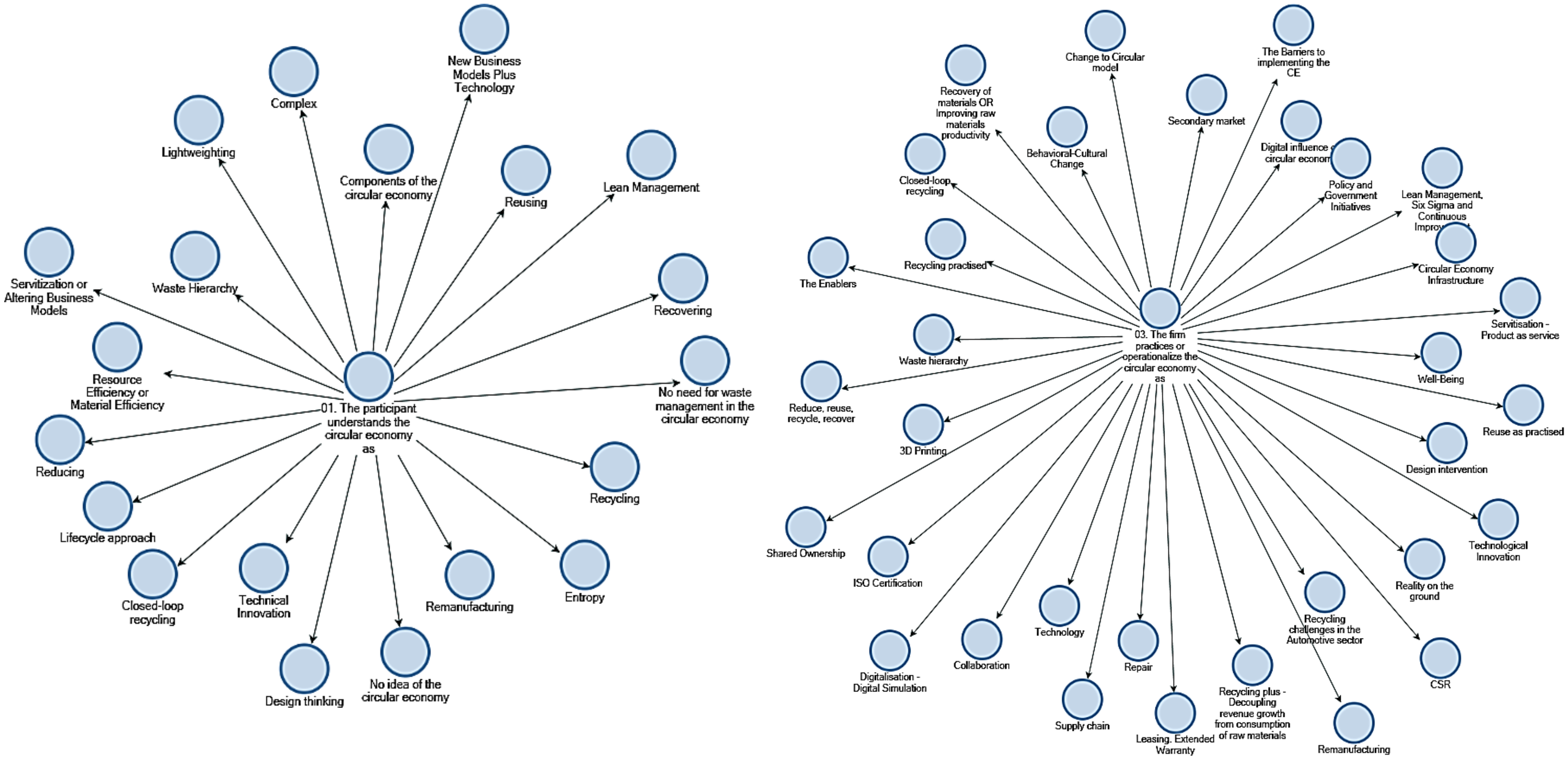


Figure 7-2: Comparing coding map- 1 for identifying main themes

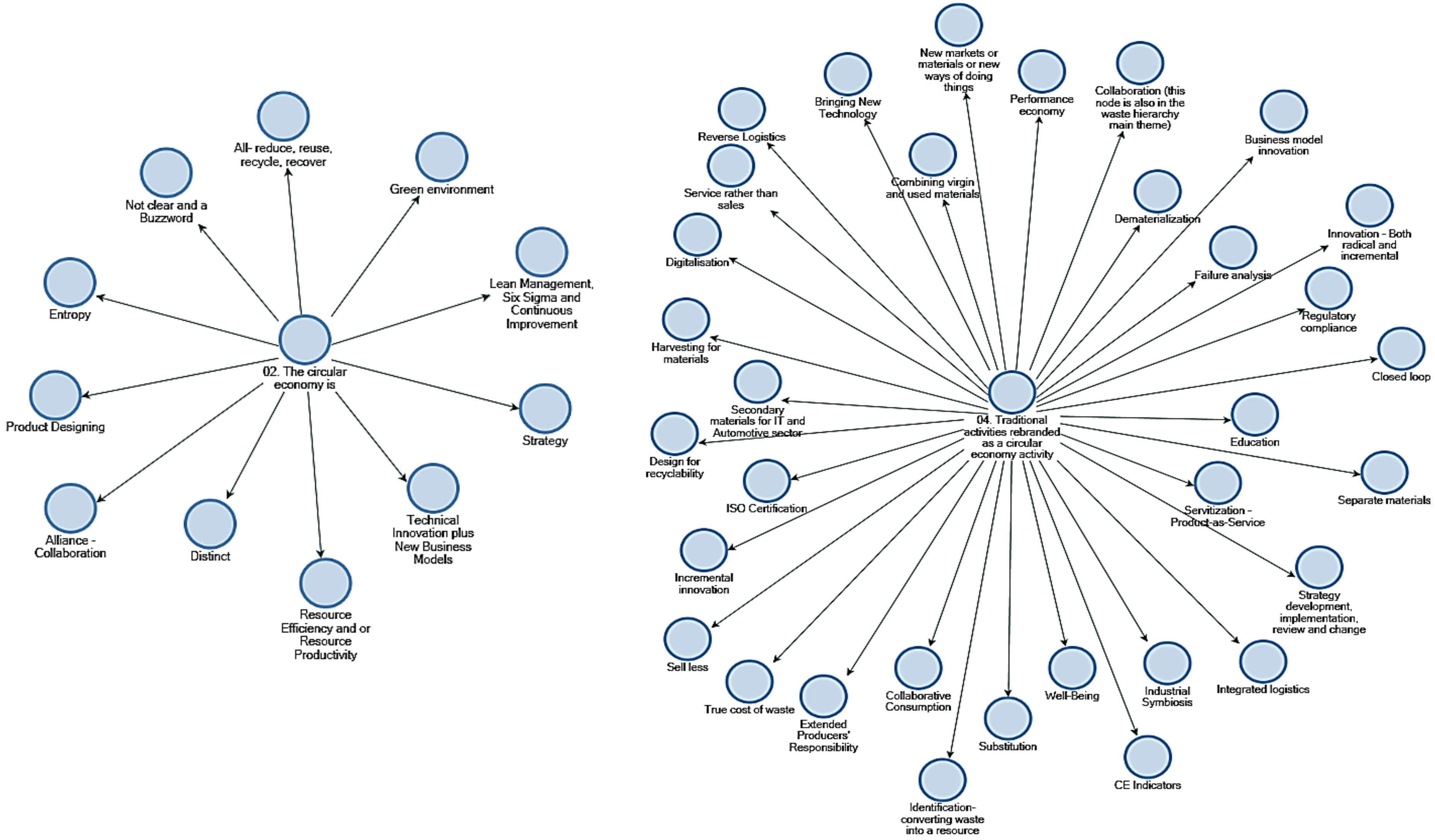


Figure 7-2 1: Comparing coding map 2 for identifying main themes

Appendix 14: The Coding process: Manual Coding-A representative transcript

INTERVIEWEE 9

Anisuddin Gabbur – Interviewee [redacted] 07.09.17

[00:00:02] Interviewer: Thank you Sussane for agreeing to take part in this research. Uh, before we begin the interview about my research I would like to state that our- this conversation, uh, is- will be totally confidential.

[00:00:15] Interviewee: Okay.

[00:00:15] Interviewer: Uh, you, your name and your company's name will be anonymised.

[00:00:19] Interviewee: Okay.

[00:00:20] Interviewer: Uh, as it is mandatory for me to follow the guidelines set out in the Data Protection Act of 1998 and in Aston University ethical policy guidelines.

[00:00:30] Interviewee: Okay.

[00:00:31] Interviewer: My two supervisors and I will have access to the information that you will provide me today.

[00:00:36] Interviewee: Okay.

[00:00:37] Interviewer: Uh, I will send you the transcript of this conversation, uh, for you to amend and approve.

[00:00:44] Interviewee: Okay, that sounds good.

[00:00:45] Interviewer: Only when you have checked the authenticity…

[00:00:47] Interviewee: Yes.

[00:00:48] Interviewer: Of the conversation and approved it…

[00:00:50] Interviewee: Okay.

[00:00:51] Interviewer: Will it become a part of my data for research.

[00:00:54] Interviewee: Fine.

[00:00:57] Interviewer: If any publication arising out of this research, if a quotation from you is used or your… I will take your written permission prior to doing that.

[00:01:09] Interviewee: Okay. Sounds good.

[00:01:11] Interviewer: I will hold this data for about five to six years in case if it needs to be revisited for checking purposes.

[00:01:18] Interviewee: Okay. Understood.

[00:01:20] Interviewer: Lovely. Are you ready to go?

[00:01:22] Interviewee: Yes.

[00:01:22] Interviewer: Is that alright with you?

File name: [redacted]echUK 070917 001

Anisuddin Gabbur – Interviewee [redacted] 07.09.17

[00:01:23] Interviewee: Yep.

[00:01:24] Interviewer: Thank you so much. Okay. N-now we've been discussing about circular economy so, uh, if I were to ask you…

[00:01:39] Interviewee: Mhmm.

[00:01:40] Interviewer: How would you describe the notion of circular economy?

[00:01:44] Interviewee: It's about keeping materials, components and products in productive use for longer. Um… and for- I think there's at the heart of it a… an- in a kind of idealised sort of scenario we would see the same materials, products and components being fed back in into- into- looped back into the manufacturing process so that they are kind of effectively continually, uh, recycled, reused, um, uh, and that more consideration is given to the materials that are used within manufacturing and design so, um, most environmentally benign, um, m-materials are selected over more hazardous- hazardous ones.

[00:02:50] Interviewer: And, uh, would you be able to context- contextualise this in terms of your IT sector?

[00:03:00] Interviewee: So, it's… the circular economy is a new-ish term for things that have been happening for a long, long time so it's described in many many different ways within the ICT sector from, um, uh, leasing, uh, companies like Xerox who are arguably some of the grandads of- of the leasing model are thriving through, uh, leasing. Uh, so, so there's this kind of innovative business model element so the leasing, um, extended warrantees, but also, uh, th-there is a healthy remanufacturing, uh, I suppose industry on the back of these innovative, uh, um, business models or alternative business models, um, and… I mean I mentioned Xerox but it- it's almost endemic within the photocopying, uh, subsector, um, um, there is also a really healthy refurbishment sector as well both by the original OEMs but also by third party, uh, refurb, um, operators, uh, a number of, uh, OEMs offer obviously warrantees what they're legally required to, some offer extended warrantees, um, and that in turn supports, uh, a whole repair network, um and- and what we've seen develop, um, if we look at Europe are either, uh, t- I suppose two different models. One, where there are regional hubs for repair and remanufacturing or, um, uh, OEMs have used contractors in local geographies to carry out, uh, that exercise for them. Um, or we have, um, third party, um, networks of repair, uh, shops that people can walk into so there are the kind of walk-in repairs or the kind of more consolidated, more manufacturing-esque sites for repair too. So, I suppose in essence it's been described and- and deployed in various different ways in different subsectors. We're increasingly seeing the sector-selling services on the back of the products so things like cloud as a service so I think they're becoming more familiar with the different ways of selling things, um, uh, they are also, um, uh, but- but refurbishments, remanufacturing and repair is still very much at the heart of, uh, the OEMs offering, particularly in B to B markets.

Regional policy

[00:06:02] Interviewer: Right. And how effective is circular economy in your terms of understanding?

File name: [redacted]TechUK 070917 001 R9 2

Anisuddin Gabbur – Interviewee [redacted] 07.09.17

[00:06:12] Interviewee: Okay. I think that, um... I personally think that circular economy is a term that has been derived by environmentalists and re-plastered onto, uh, manufacturing activities and I'm not sure whether it's got traction within general business, general manufacturing at all. It certainly has traction within the, um, sustainability functions within the OEMs but whether that's diffused across the business I remain unconvinced. Uh, a good example is actually the first time Samsung has just released its sustainability report has just identified circular economy as its number one material environmental issue to manage. Um, and presumably that- because it already has [unintelligible 00:07:11] climate change but not really the same sort of targets and goals for circular economy. So, it's starting to become more pervasive but I still think a lot of people think of it in terms of recycling and I think that's a perception that's, um, also been, uh, accentuated by the waste industry at times I think because I think they have an economic value, uh, economic incentive to- to- to focus on the- on that bit of the- of- of- of the circular economy, um, and, um, less so around some of the other activities. I think the circular economy action plan as well, the waste elements of it have- I think have confused really what the circular economy is all about so I think, um, uh, there's still more work to be done for it to be generally understood. For a lot of manufacturers [unintelligible 00:08:09] is a term that they're much more familiar with and which is a better way of almost describing circular activities in business language.

RQ

RQ

RQ

driven by waste industry

CE more work required

Servitization

first time CE linked to Servitization

[00:08:18] Interviewer: Right. Right. Thank you so much for that. My next question is in your view do [unintelligible 00:08:34] do managers at the firm level understand what circular economy is about?

[00:08:43] Interviewee: Um, I think sustainability managers get it now but broader than that, possibly not. Um, I see lots of sustainability managers using different languages, different languages and different terms to persuade the board, to persuade other parts of the business to sign up to various initiatives, um, but of course that varies from company to company, um, but through established OEMs, um, I think it tends to still remain within the consciousness of the sustainability leads.

only S managers

[00:09:23] Interviewer: So, do you mean to say that sustainability is synonymous to circular economy?

[00:09:30] Interviewee: I think so. I think businesses understand resource efficiency, they understand I think resource productivity. We- we've seen for years these- you know previously these incremental increases in resource efficiency at [unintelligible 00:09:48] level, efficiencies in how you know we might reduce exp- dependency on expensive materials, um, I think... I think what's happening now is that the sustainability leads are, um, presenting kind of new opportunities in- in- in their- in a broader context, um, part of that I think is around the resource, uh, security agenda and we know of certain UK manufacturers for example, um, not in ICT but certainly in other sectors, uh, taking firm, um, initiatives within the- within the firm, um, to try and manage their materials, um, but, uhh, I think it doesn't necessarily need to understand what it is. I think it just needs to recognise that there is, um, a range of new and different options that can leverage competitive advantages, um, and- and reflect on those. It might not be for every company but, um, it- I think it still remains largely the gift of the sustainability manager to push those messages, um, within the company. Unless it's a disrupter.

RQ

Competitive Advantage

RQ

File name: [redacted] TechUK 070917 00

[00:11:27] Interviewer: Right, so do you- do you, uh, think that a disrupter is, uh, ~~an~~ enabler of circular economy?

RQ

[00:11:39] Interviewee: Um, in the tech sector I would say yes. We are seeing disruption all over the place which will look to enhance I think can support other sectors in being more resource efficient and help manage their supply chains better. T

[00:11:57] Interviewer: [unintelligible 00:11:57] Can

[00:11:59] Interviewee: So, one of the examples is a- a small NGO called Provenance, they do block chain and they're managing and tracking materials and products across the supply chain. They're doing some really exciting work which I think can have real benefits, uh, on a much higher- higher, um, wider, um, level, uh, once people get their head around it and trust the technology, uh, machine learning is another, and AI is a- is another potential area which can perhaps, uh, speed up repair activities, um, maybe could help to, um, uh, ensure that products are appropriately channelled at their first end of life say to the option, management option which could, um, allow the most value to be obtained from it, for example, Xerox has a global inventory of spare parts and materials and when it has new product coming back it will then check to see exactly, um, how it can make the most money out of the product that's coming back. It's completely focused on abstracting as much economic value out of that product at the end of life and they've- they've got there over many many years but they're I think one of the leading companies in how their- how their mindset is already adjusted to extracting that value at the end of life. Not enough companies are thinking about the opportunities there but the waste sector is [laughs].

PA RQ T Value RQ T Value

[00:13:42] Interviewer: Right.

[00:13:43] Interviewee: And if they don't, the waste sector will- will- will take that economic, um, value themselves. RQ

[00:13:50] Interviewer: Wonderful. Right, in your opinion, what are the barriers to achieving circular economy?

[00:14:01] Interviewee: Okay. I think there are a number. First of all, I think there is- remains, um, uh, an aversion- an aversion by businesses to change. Um, I think while companies have to change, uh, you know it does mark a- a really radical departure from business as usual and in highly competitive, fast moving markets I think, uh, you know in the business, uh, case for changing what they're profitably earning and you know they're succeeding in is a challenge. Huge challenge. So, that's number one. S- um, secondly, I think it's, um, trying to get a consistent view about what is actually a desirable outcome so what is it, uh, that is the most important, uh, I suppose, uh, outcome that- that a government, jurisdiction, stakeholders think- think is needed so for example one of the criticisms I've heard around Apple's commitment to end mining is some scepticism because they- it implies that they will take back all their phones into a close loop manufacturing, uh, situation. Either they will disassemble and harvest components, reuse, repair what they can or they will, um, break everything down to its constituents and then- or molecules and remake a new one. Um, and a lot of people say well you're then excluding- that's complete ownership and you're excluding a lot of third party

Teece OC mkts Industry characteristics

Anisuddin Gabbur – Interviewee [redacted] 07.09.17

activity, the involvement of other businesses in profiting from maybe repairing or recycling those products. Um, so, um you know is it the closed loop is the best (3) outcome? Is it that actually designing for durability is really important because through designing for durability will you get enough product back in order to support (4) maybe re-manufacturing and repair and how do you square that all? I think one of the challenges I've seen not necessarily in this particular sector but in other manufacturing sectors is making sure that there's enough core coming back to remanufacturing plants in a sufficiently predictable way to support, um, a (5) manufacturing process so I think that's a r- a massive issue, um and actually the kind of delivery of that product, the reverse logistics of that product, how can you make sure that that is done in a- in a cost-effective way? Another barrier is around the ~~[unintelligible 00:17:07]~~ directive. At the moment targets are based on e-place on the market. There isn't sufficient analysis done of the- on- on, uh, or recognition for (6) companies that are taking back their own waste. Um, in fact there may be financial disincentives for companies to take back their own waste, uh, which is not in the spirit I don't think of the directive. Um, equally you know if- if targets to recycle are placed on e-place in the market, well it sort of...

cf. Malcolm ... ATP

Electric & Electronic

[00:17:46] Interviewer: On... E?

[00:17:48] Interviewee: Uh, E so that's electrical and electronic waste... Electric & Electronic Equipment placed on the market

[00:17:50] Interviewer: Right, okay.

[00:17:51] Interviewee: Sorry, equipment placed on the market. You know there is a- there's always going to be a- I suppose a desire to, uh, recycle and so that in (7) itself could dampen other models and it's particularly for consumer, um, products that this is based so I think we could look at the, um, ~~to~~ directive again and say well, is it fit for purpose for a circular economy ~~[unintelligible 00:18:19]~~ actually under a logical, you know logically we would have a zero target for recycling and everything would be reused, repaired and recovered and we wouldn't be recycling at the end of life. We wouldn't have to collect from local authorities so I do think that while when it was d- initially designed it was right, it was designed to- to ensure that electronic, uh, and electrical equipment wasn't re-disposed of in landfill and it did the job of preventing that) but, is it fit for purpose in the context of circular economy is (9) debatable. Another major barrier is the interface between chemicals, products and waste regulation. So, where does the competing agendas within Europe for a non-toxic environment and a circular economy, how can they happily co-exist because there are materials, products, components out on the market whose composition we don't know and cannot be determined unless we subject it to expensive chemical analysis. Well, how can we then place it back on the market with any confidence that it meets, uh, increasingly broad, uh, restrictions on the use of substances? (10) How do we know that the substances that we're using today are fit for purpose in the future because we're still understanding what the risks are associated with these (11) substances? In my view, the lack of the certainty around exemptions for spare parts is disappointing because it's sending a signal to the market not to hold on to stocks for spare parts, um, longer than you have to and that effectively drives up the cost of- of obtaining spare parts because- and supporting this kind of, um, um, and undermining really the case for durability so one example is, um, a recent restriction that went through reach, uh, we highlighted to our member state to [unintelligible

REACH

Design for Durability DEFRA

File name: [redacted] TechUK 070917 DD (19)

00:20:39] that it would prevent us repairing existing data centre and telecoms equipment that were designed to last about 20 – 30 years and that they would have to be scrapped early if we were not able to get this exemption. In fact, what they did is commission gave exemptions for semiconductor manufacturing equipment, uh, I think for university equipment but said they'd already given industry too much and- and gave only a 5-year time limited exemption for the products that we were- uh, spare parts that we asked for a longer exemption for. Um, and it- it- it's those sorts of actions I think which undermine the market for durable products, um, and- and- and healthy repair activities. Um, so, um, so that's one major legislative issue. (12) Another one is- and that links to the cost. So, cost is always going to be I think the number one barrier, um, repair products, reused, remanufactured products have to compete with evermore efficient manufacturing of new products with a much kind of lower, um, uh, wage, uh, price point so, um, how- how can- how can we keep cost down to make it compete, uh, in a sensible way and that's both at the product level but also at the material level and this is obviously played out you know on plastics. (13) Um, I think another barrier is around consumer acceptability. Consumers still think sometimes second-hand stuff like particularly technology is a little bit rubbish. It might be likely to fail it might have viruses or bugs on it. Some consumers hoard products because they're concerned about the data that's stored on the product. They don't know how to safely erase the data so they keep it in their house so it's not being fed back into repair, remanufacturing, refurbishment activities so there's (14) clear issues around that too. Other barriers, in the UK specifically is Brexit and uncertainty about the movement of product for repair, refurbishment and remanufacturing in and out of the country, will that add cost and then how will that then... what will that then mean for, um, what will that then mean when you're competing with new products? Again, you're adding costs to already a very sensitive, um, uh, market. Um, so they're some of the barriers that come to mind immediately. I think maybe, um, there's probably a hell of a lot more. I think some of (1) the ones that we picked up on are more business internal issues. How do you design contracts for innovative business models? How can you cost in all the things that could possibly go wrong with a product to make sure that you know that- t-t-that the contract is, uh, reasonable to the, uh, user but also profitable to the company, I think is still a challenge. Um, and, uh, so yeah, I think I'll leave it there. I'll let you know if I have any more thoughts on that.

RQ

[00:24:07] Interviewer: Lovely, thank you.

[00:24:11] Interviewee: (3) Another actual barrier, and I can't remember the specifics but it's about company accounting and how they account for products which aren't... how they account for materials and products, um, I recall this being highlighted a number of times as being a real issue that it's not you know when you're looking at resource scarcity and material pricing, this isn't being factored at all into company accounting and in fact, actually holding onto stock sometimes devalues, depreciates, yeah. So, um, it's worth picking that up with other specific companies about that point. Depreciates exactly.

[00:24:58] Interviewer: Thank you for that. Uh, my next question is can you think of any enablers that help implementation of circular economy?

[00:25:06] Interviewee: Mhmm. Okay, so I suppose trends like demographic change, material pricing, uh, the ongoing attention to resource scarcity and specific incidences of resource scarcity have helped to position, um, CE solutions as, um, as attractive business opportunities and options. This kind of resource resilience, uh, narrative, uh, and equally like the work of people like [unintelligible 00:25:43] McKinsey WRAP Chatham House, um, Ellen MacArthur [~~unintelligible 00:25:49~~] you know this outreach, um, two businesses I think is also- they're acting as enablers as well. Um, and then of course kind of government funded innovation bodies like Innovate UK RQ and others, um, are helping too so I think it's mega trends, it's external bodies and thought leaders, um, and then the kind of individual, um, individual, uh, sustainability managers. At the moment I don't think that there's many more incentives than that. What we're lacking is you know green public procurements, uh, in this area, in lots of areas, ah, although it's something I think will be looked at soon by DEFRA [~~unintelligible~~ 00:26:38] Challenge um, and, uh, we're lacking physical incentives to encourage for example the reuse of recycled materials, um, so and we're really lacking the kind of a very enabling policy framework.

[00:26:56] Interviewer: And do you think this NGOs like Ellen MacArthur Foundation and, uh, you know other, uh, NGOs like circular economy, circular economy those... what is their role really in, uh, in- in- in promoting the concept of, um, resource efficiency or circular economy if I may extend that too?

[00:27:25] Interviewee: I don't have an amazing insight into the work that they do directly with companies so for what I could say is I suppose that they've got an advocacy role, championing the outcomes and the opportunities from adopting and embracing circular business activities. Um, and I think they've also got a facilitation role to bring together, um, supply chains and industries and actually people with inside- inside any one particular business to start working through and thinking about what- what are the opportunities for their business.

[00:28:08] Interviewer: Right. Okay. Right. My next question is how would you define waste?

[00:28:17] Interviewee: I think I've been conditioned by the- the legal definition so anything that's been discarded by it's owner.

[00:28:26] Interviewer: Can you elaborate a bit more please?

[00:28:30] Interviewee: So, it's more of a kind of psychological definition really because it- it- is actually relates to the point- it actually means that the person who discards it has taken a view that it's no longer of value or of use and have therefore decided to dispose of it which means it will then go through channels which invariably mean it's going to be burnt, squished or buried.

[00:29:09] Interviewer: Right. Assuming if you personally were to improve the waste management process, what would be your first steps?

[00:29:22] Interviewee: Alright, well I'd introduce consistency across local authorities. Um, I would, um, make it so there would be standardised collections. Um, recyclers would produce materials to a certain specification which would then give, uh, end markets greater certainty over the materials that they were buying. Uh, they were- I would also reduce VAT on recycled materials, um, to support that too. Um, and… yeah, how else would I improve it? Uh, I think that would be a good first step.

[00:30:10] Interviewer: Right. Is effective waste management a part of your idea of circular economy?

DICHOTOMY

[00:30:20] Interviewee: No because under circular economy there shouldn't be any waste management so it's always struck me as somewhat odd that [unintelligible 00:30:28] who are meant to be championing, um, circular economy is- is also in charge of growing the waste sector. That was a- that was a priority of it in the past and I just thought they were two completely conflicting objectives, um, so, um, no, there shouldn't be waste management. It's- it's resource management. Effective resource management is what circular economy is about and not waste.

DEFRA

RQ

Very Imp

[00:30:59] Interviewer: Right. What is your idea of resource efficiency?

[00:31:07] Interviewee: [clears throat] It's about, um, well resource efficiency is about limiting our reliance on I would say virgin material so using what materials we have as effectively as possible.

[00:31:29] Interviewer: Right.

[00:31:30] Interviewee: That's it.

[00:31:30] Interviewer: Any other thoughts?

[00:31:31] Interviewee: [laughs] and that could be on a- I suppose a process level, uh, and a product level, um, and, uh, I would say that it can be deployed in- on product level in many different ways and it's all those things that we've already talked about, making sure a product is more durable, repairing it, um, making sure it's easy refurbished or, uh, remanufactured perhaps harvesting components, um, if it can't be repaired or remanufactured at the end of life and then recycling whatever is left. For me that seems like a pretty kind of resource efficient hierarchy. Um, uh, and then actually making sure that in the manufacturing process itself it's using as little resources as it possibly could. I suppose the kind of area where that- that might be in conflict is whether nano- the use of nano could be considered resource efficient but not necessarily support effective recovery of those materials at the end of life so there is a tension there I think between reducing use of expensive, um, maybe scarce materials through nano and being able to recover it at the end of life, yeah.

Imp Concept

Resource Efficiency Hierarchy

NANO

Challenge

[00:33:00] Interviewer: Right and how could you deliver greater economic value?

[00:33:08] Interviewee: Okay, so there is clear, um, clear- there's so much evidence out there which shows that, um, at the OEM level and their supply chains, cutting resource efficiency reduces their overheads, their material costs which all lead to profit so there's obvious benefits for businesses to adopt resource efficient, uh, behaviours. For consumers, it depends on whether those savings are passed down to the consumers, uh, but it might enable you know OEMs to offer a more competitively prices product, uh, and enable them to compete more effectively, Reflexion

This is drawn from past industry experience with media + broadcasting. The same may not be true for another market / another geographical location ??

Eg Indian Media Industry

Reflect

This sector is in its infancy. There is a need for consolidation. But the challenge with big corporations is that they cannot step in (ramp investment) to consolidate. When the consolidation happens when the sector has reached its maturity after yet fragmented. This kind of structure is not visible yet.

Anisuddin Gabbur – Interviewee [redacted] 07.09.17

certainly historically what we've seen is a lot of companies adopting resource efficient behaviours at times of downturn or when material prices have gone up to try and keep prices stable, um, and then when things have returned to a kind of more normal position they've maintained that and found that they will be more profitable as a result. Um, but, uh, and then of course how you manage particular resource streams, um, uh, you can extract you know I suppose it depends on what it is but obviously there's value to be extracted also from the resource streams at the end of life as well, um, and a good example, it's not my sector but in the kind of, um, food waste, it was touched on today about biorefineries, higher value products being, um, uh, obtained from, um, uh, anaerobic digestion so things like instead of just, yeah, burning things for energy, can we get higher value chemicals and molecules from that material. So, um, I think, uh, resource efficiency doesn't necessarily support- co-exist with extracting the most value out of that activity but it should do increasingly. Does that make sense? ← Imp

[00:35:38] Interviewer: So, you mean to say, uh, [unintelligible 00:35:41] a product. Cascading

[00:35:42] Interviewee: Yeah.

[00:35:43] Interviewer: [unintelligible 00:35:43] Cascading a resource

[00:35:44] Interviewee: [unintelligible 00:35:44] Cascading

[00:35:45] Interviewer: Does not help?

[00:35:46] Interviewee: It does help, yes, yes, yes. So, the... obviously I think cascading of materials is a relatively new concept I think. Now, Scotland does it in terms of the best sort I suppose the best waste management outcome for a particular product or material. It's happened- it's now for food but relatively only the last few years, um, and um, and I'm not sure whether that thinking has been embedded and in fact we've heard today from anaerobic digestion association that it isn't embedded, that there are councils still burning you know food waste, um, because, um, and not actually thinking about well what's- how can I gain the most value out of the materials here so you know their behaviours are probably more resource efficient but they're not necessarily gaining the most value out of that activity.

RQ

Addressing Dichotomy

(T)

[00:36:45] Interviewer: Right. And what is your notion of profit?

[00:36:50] Interviewee: Uh, [laughs] it's, uh, I suppose, I work for a business association so we don't have any profits but, um, it would be for a business to earn more than it is spending, for its revenues to exceed its expenditure.

[00:37:12] Interviewer: Right, and what should be the notion of profit in terms of, uh, in the context of circular economy?

[00:37:19] Interviewee: Oh, [laughs], uh, okay. I think I'll go back to that point I talked about, um, about accounting within companies and actually there needs to be, um, I suppose a mind shift, a paradigm change in- a shift in how we view materials in use, in stocks and the value attached to it, um, so I think, I think more

Accounting + Valuation

File name: [redacted] TechUK 070917_001 (pg 9) could be done for accounting for circular economy perhaps. That's probably another PhD thesis in its own right isn't it.

[00:38:04] Interviewer: Yeah.

[00:38:05] Interviewee: [laughs] So, Tech UK has, um, over 20 different programmes, a proportion are market facing so it's companies wanting to access markets like local governments, central governments, defence, healthcare, um, they're the ones I can remember, um, there are also some which are focused are technology so it would be things like, um, big data, internet of things, connected home, smart energy, um, then we have a whole bunch of other programmes that look at things like, um, telecoms so, um, uh, rollout of 5G, spectrum policy, um, and, uh, and those sorts of kind of core issues. We also have an electronics programme that does a lot of the discussion with broadcasting sector, understanding really what BBC are planning to do because they've got a huge innovation budget and R&D budget, um, and how that aligns with what manufacturers are doing and try and get some sort of compromise in the middle, um, and make sure that's there. Um, and then some policy facing, um, programmes so my programme is predominantly helping, uh, businesses to remain compliant in environmental legislation, keep on top of that and keep on top of policy developments but also around product safety I cover and export controls. Um, for dual use of equipment and we also have, uh, a women in tech programme as well which is very popular.

[00:39:54] Interviewer: Okay.

[00:39:54] Interviewee: Yep.

[00:39:57] Interviewer: What role do you see of legislation in the circular economy context?

Legislation as a Barrier

[00:40:04] Interviewee: Okay, I think it's really really important, uh, I mean I- I don't see it as an enabler but it's- it's got to- the framework has got to allow and enable circular, um, business activities to happen so the example I gave earlier about the tension between the non-toxic environment and circular economy agendas within Europe, um, causes real confusion in the marketplace, uh, and actually acts as a barrier, um, and created inertia so you know these sorts of uncertainties need to be eradicated, um, we need to understand kind of you know what is the priority here because it will reframe how companies must think about circular economy, um, there may also- I-I think more- more substantially there's a role around standards, um, and I-I've mentioned it as well but the use of recycled materials you know we need- it needs to be standardised but again you know we need to make sure there is some allowance about legacy products and materials, um, so I think standards have a clear role for the materials that are used or recovered, um, I think legislation must be supportive, um, but it's still needed I think in the waste sector particularly it's so open to abuse, there's always going to be somebody who finds loopholes so it still needs appropriate checks and balances to make sure that for example ICT products which are you know said are going for refurbishment or repair are actually going for refurbishment and repair and aren't just mixed loads that are being dumped somewhere inappropriately so we still need the appropriate checks and measures to make sure that responsible business is occurring. Um, I also wonder whether you know we need EPR for [unintelligible 00:42:25] um, maybe for some specific, um,

WEEE

Anisuddin Gabbur – Interviewee [redacted] 07.09.17

Patterns

· Enablers

· Barriers

· Dichotomy

· Legislation

· Core Elements

[redacted]

waste electrical products that have a value at- it costs to recycle. Um, uh, we still need it but I think there is plenty of informal activity that isn't going through the traditional routes that we're just not- we don't have the data on, we don't know what's happening in the market so I think there's maybe a role around data generation that legislation can help generate that will enable us to have a better understanding about a flow of materials and products through the economy. Um, there was discussion about waste data flow at some point. Maybe blockchain technology could also provide some interesting solutions here so I think there is a legislative point around data which still hasn't really been addressed which I think you know until we have an informed understanding of what's happening in the market only then can you start to think about legislating for it so I think the data comes first and clearing the policy barriers is kind of first step.

Provenance

Lack of mkt information does not help legislating

RQ

[00:43:41] Interviewer: Right. In your opinion what are the elements of circular economy?

RQ

T

[00:43:46] Interviewee: The elements. Uh, I mean from a purely process view it's design, it's design for durability, just design, uh, material selection, um, it's then you know the- the reuse, repair, uh, recycle, you know refurbishment, remanufacturing, I'd put remanufacturing ahead of refurbishment, recycle, um, and then if it can't be recycled energy recovery in a purely sort of process, uh, looked I suppose in another way it's- it's- it's collaboration, it's holistic thinking, it's new- new ways to talk to your customers.

← RQ

T - systems thinking ??

[00:44:52] Interviewer: New ways to?

[00:44:53] Interviewee: Talk to your customers, developing new relationships with your customers and your suppliers, um, and I don't that's been adequately kind of- kind of the- kind of business responses that are required, maybe it's in that maturity matrix that BSI have produced and we haven't seen that yet. It's these sorts of inward processes, um, I think we need to probably map a bit better you know what are the steps that you need to take to start to kind of move on that journey so I would be interested to see that maturity matrix that BSI have developed their economy, their circular economy guidance.

[00:45:33] Interviewer: Right. If you could have a system that would help you to change to circular economy.

[00:45:39] Interviewee: Mhmm.

[00:45:39] Interviewer: What would be the core elements of the system?

T

T

[00:45:45] Interviewee: I- I think it would- it would have, um, okay, so it would have- it would need to have, uh, um. a well thought through strategy for reverse logistics I think is the first point so how do you get products back for repair, back for reman, back for refurb in a cost-effective way which does not damage the product or devalue it. We are already seeing that when consumers return products to stores if there's been a fault often those products are trash because they're not stored properly, um, and they would have to just be recycled or, um, have parts, um, scavenged, harvested from it, um, so I think reverse logistics is a core element and I don't think the likes of DHL and logistics players have been adequately brought into

RQ – Enabler

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Resort (Reture)

these conversations around circular economy yet. Uh, one of the things we've thought about were things like [~~unintelligible 46:59~~] distribution centres where you can start to consolidate loads until it becomes economical to then transport it back to a manufacturing site. That might work if there's some lower value materials, um, that might be, uh, un-economical to bring back otherwise, um, I think it would also need to have you know a much more supportive fiscal, uh, base which, uh, incentivised circular economy activities as well and materials, um, and maybe it would also need to have a kind of totally- a k- a k- a market which were receptive and willing to accept, uh, and embrace these different ways of selling products, um, and responding to the end of life, uh, options that were available.

[00:48:00] Interviewer: Right. Right, thank you so very much for all of that wonderful insight. My last question is do you think you have any more relevant information to share that I haven't asked.

[00:48:16] Interviewee: Okay. I think I'll mention a couple of points, one of which is, um, in connection with, uh, the likes of Ellen MacArthur who is often seen as kind of thought leader in this area. I think there is a kind of super- I think a suspicion within the market and certainly when we've tried to engage with them they've been very reluctant to work with us and partly I think that's because we don't have a huge budget despite working for tech sector, I think you might assume that we might do but no. We are non-profit so, um, I think- I think this is almost is becoming almost a- it makes it a bit of an elitist engagement to- to work with Ellen MacArthur. I'm not sure how many NGOs are working with them but I do know that companies that have worked with them are putting substantial amounts of money into it. Um, so I won- I'm a little bit suspicious of- I'm not suspicious but I don't think they're kind of operating for the global good let's say. There is a clear kind of profit, uh, motivation in- in- in how they're operating. I'd also say that you know recently Therese Coffey, the current environment minister mentioned at a public meeting I attended that she didn't like the term circular economy. She hated it she said because it implied not for profit, non-profits. She preferred the term resource productivity so I wonder whether you know this is a sign you know that circular economy in itself you know whether we- whether the language is right you know as environmentalists we understand what circular economy means but is it fit for purpose for the- for the wider community, to engage with politicians, to engage with the business community and I think that in itself is debatable. Um, and- and I think there is also a little bit of circular economy fatigue within the business community you know a lot of people have been talking about it for a while. There's been lots of theory, lots of discussions about what the potential is you know how wonderful it could be, this kind of utopian dream of production. The reality has proven somewhat different and we're not seeing the practical examples that have been promised coming to bear. People are struggling to make it work and, um, I think until more positive, practical examples of circular economy start coming to- coming to light you know the- the kind of scepticism with the- with the term, it- it will just continue to grow, uh, I think resource efficiency is something businesses understand, uh, and they can sell but circular economy is- is a much more difficult proposition. Uh, yeah, so I think those are the kind of three kind of additional things I would- I would mention.

The main Barrier

[00:51:33] Interviewer: Fantastic. That was really wonderful insight. But just one question stemming out of you know the budget thing that you mentioned, this kind of elitist, uh, you know it's becoming an elitist activity or people who have money can you know think of doing circular economy.

[00:51:52] Interviewee: Yeah.

[00:51:52] Interviewer: Elaborate a bit more on the budget side of things please.

[00:51:56] Interviewee: Um, okay, so I heard that, um, some companies were putting six figures into Ellen MacArthur to engage in the programme you know most companies are not going to have that sort of money to invest. I mean maybe, I don't have sight of all the whole offering but, um, I- I think for the majority of companies they were- they would struggle to engage with the likes of Ellen MacArthur because they just don't have the- the budget and the resources to draw on to be able to do that. Um, so, there's only so much- I mean it's fine for your big global blue chips but I think beyond there looking deeper into supply chains I- I think there- there will be limited impact from- from those types of organisations.

V. Imp

The main Barrier

[00:52:45] Interviewer: Lovely. Thank you so very much. Thank you.

[00:52:48] Interviewee: You're welcome.

[00:52:49] Interviewer: Will we be okay for a follow up meeting or a conversation on this if it is required.

[00:52:55] Interviewee: Yeah, sure, no problem.

[00:52:57] Interviewer: Lovely. Thank you so much for your time.

[00:52:58] Interviewee: Okay.

[00:52:59] Interviewer: Thank you.

[00:00:04] Interviewee: I think another point I'll just mention is the huge influence in the UK of the waste sector. Now, I think to put this into kind of context you know a lot of politicians and ministers like CEOs of companies. As a tech sector we're companies who are operating globally, you can't wheel out a CEO to speak to an environmental minister, it's just not going to happen. But the waste industry is very able, um, to deploy their chief executives to engage at that sort of level, um, and doing so frequently. You go to Westminster, the place is absolutely, uh, throbbing with waste management lobbyists, um, and experts and I think they've almost ceased the circular economy agenda, uh, and they have taken it down to kind of its base levels. You'll see that there is a lot of discussion around, uh, reforming EPR and what they want is design for disassembly. for the focus of the waste sector is all about designing for disassembly, um, and to create value at the end of life. That's not necessarily the best environmental outcome, and I- I think I'll go back to a point I made when I spoke at an event today and that is for particular products who need to consider what the- you need a really an LCA to determine what the environmental, uh, impacts that you need to control best and I think just the assumption that everything needs to be recyclable is wrong, um, and I think kind of history has taught us that everything that environmentalists think are a given is always- is never backed up by the data, um, so I do think that this has is also being- the agendas

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move- has moved and it becomes one about recycling, uh, and I think there is a real danger that everyone else will see it as a recycling thing.

C.f Malcolm Harris

[00:02:10] Interviewer: So, you mean to say they will see circular economy as recycling.

[00:02:14] Interviewee: Yes, yes. And that they are one in the same. To recycle is to participate in circular economy and all the higher value activities The- the- the opportunities for example to generate higher skill deployments, um, to get more value out of resources, will get ignored. Yeah, that's my last point.

C.f Malcolm Harris

[00:02:36] Interviewer: Thank you.

Appendix 15: List of all nodes, coded files, and number of references

Table 7-4: List of all nodes, coded files, and number of references

Name	Files	References
01. The participant understands the circular economy as	40	465
Name	Files	References
Closed-loop recycling	7	13
Complex	7	7
Components of the circular economy	8	25
Name	Files	References
Dimension of the CE	9	19
Name	Files	References
Economic	1	1
Environmental	2	3
Socio-political	3	4
Name	Files	References
Design thinking	11	21
Name	Files	References
Design for regeneration, renovation and renewal	12	25
Name	Files	References
Entropy	2	9
Lean Management	6	15
Lifecycle approach	2	3
Name	Files	References
Life-cycle analysis - Cradle to Cradle approach	6	13
Name	Files	References
Light weighting	3	4

New Business Models Plus Technology	7	10
Name	Files	References
New Business models	3	4
Name	Files	References
No idea of the circular economy	7	9
No need for waste management in the circular economy	3	4
Recovering	5	7
Name	Files	References
Material recovery for IT and Automotive sector	12	48
Name	Files	References
Recycling	32	85
Name	Files	References
Recycling plus-Decoupling revenue growth from the consumption of raw materials	11	19
Name	Files	References
Reducing	23	45
Name	Files	References
Reduce environmental impact	2	3
Reducing	17	46
Substituting	1	1
Name	Files	References
Remanufacturing	8	22
Name	Files	References
20. Regeneration	1	2
Re-engineering	6	9
Refurbish	3	4
Name	Files	References
Resource Efficiency or Material Efficiency	13	30

Reusing	21	35
Servitization or Altering Business Models	5	16
Name	Files	References
23. Leasing	5	6
Name	Files	References
21. Doing more with less	1	1
Name	Files	References
Technical Innovation	8	12
Name	Files	References
Automation	7	46
Name	Files	References
Digitalisation	1	9
Name	Files	References
Waste Hierarchy	8	18
Name	Files	References
19. The Waste-as-resource	1	4
02. The circular economy is	9	14
Name	Files	References
All- reduce, reuse, recycle, recover	18	42
Alliance - Collaboration	1	1
Distinct	10	94
Entropy	2	10
Green environment	5	6
Lean Management, Six Sigma and Continuous Improvement	6	20
Not clear and a Buzzword	40	88
Name	Files	References
Buzzword - Complex	5	7
Morale based	1	4

Normal business practice	3	4
The CE is an old concept	16	29
Name	Files	References
Product Designing	1	3
Resource Efficiency and or Resource Productivity	6	11
Name	Files	References
Waste flows	3	4
Name	Files	References
Deliver Value	3	5
Name	Files	References
Strategy	7	10
Name	Files	References
Branding strategy	7	9
Name	Files	References
Technical Innovation plus New Business Models	2	6
Name	Files	References
New Business models	3	4
Technical Innovation	8	12
Name	Files	References
Automation	7	46
03. The firm practices or operationalize the circular economy as	32	294
Name	Files	References
3D Printing	4	36
Name	Files	References
Behavioural-Cultural Change	5	11
Change to Circular model	1	2
Circular Economy Infrastructure	14	25
Closed-loop recycling	6	13

Collaboration	68	317
CSR	2	4
Design intervention	11	19
Name	Files	References
Design for regeneration, renovation and renewal	15	38
Name	Files	References
Digital influence on circular economy	1	11
Digitalisation - Digital Simulation	4	30
ISO Certification	2	2
Name	Files	References
EU Classification	2	2
ISO 14001	4	4
Name	Files	References
Lean Management, Six Sigma and Continuous Improvement	6	21
Leasing. Extended Warranty	1	1
Policy and Government Initiatives	24	230
Name	Files	References
Circular Economy Infrastructure	11	19
Collection Policy	5	7
EU funding	2	5
Government incentives and support	7	26
Legislation (2)	20	55
Policy	6	9
Remit of Government Agencies	6	21
Name	Files	References
Reality on the ground	2	6
Recovery of materials OR Improving raw materials productivity	6	19
Recycling challenges in the Automotive sector	15	105

Recycling plus - Decoupling revenue growth from consumption of raw materials	1	3
Recycling practised	25	230
Name	Files	References
Re-engineering	1	3
Name	Files	References
Reduce, reuse, recycle, recover	5	11
Remanufacturing	5	23
Name	Files	References
Re-engineering	5	11
Name	Files	References
Repair	1	1
Reuse as practised	11	19
Secondary market	5	7
Servitisation - Product as service	2	7
Shared Ownership	2	2
Supply chain	16	63
Name	Files	References
Reverse logistics	20	90
Name	Files	References
Technological Innovation	47	374
Technology	2	2
Name	Files	References
Proprietary technology	1	2
Name	Files	References
The Barriers to implementing the CE	19	100
The Enablers	11	47
Name	Files	References

Levers of change or Transition 2CE	6	26
Name	Files	References
Waste hierarchy	8	9
Well-Being	4	13
04. Traditional activities rebranded as a circular economy activity	8	48
Name	Files	References
Bringing New Technology	9	13
Business model innovation	9	42
CE Indicators	3	7
Name	Files	References
Metrics	1	3
Name	Files	References
Closed loop	3	4
Collaboration (this node is also in the waste hierarchy main theme)	13	37
Collaborative Consumption	9	16
Combining virgin and used materials	12	32
Dematerialization	4	7
Design for recyclability	15	175
Digitalisation	3	29
Education	2	2
Extended Producers' Responsibility	3	4
Name	Files	References
dynamics of cans and litter strategy	2	3
Name	Files	References
Failure analysis	1	3
Harvesting for materials	1	1
Identification-converting waste into a resource	8	23
Incremental innovation	5	7

Industrial Symbiosis	1	1
Innovation - Both radical and incremental	3	6
Integrated logistics	2	2
ISO Certification	2	2
Name	Files	References
New markets or materials or new ways of doing things	4	10
Performance economy	4	7
Regulatory compliance	2	4
Reverse Logistics	3	13
Secondary materials for IT and Automotive sector	8	19
Sell less	1	2
Separate materials	2	12
Service rather than sales	1	2
Servitization - Product-as-Service	3	4
Strategy development, implementation, review and change	5	19
Substitution	19	87
True cost of waste	1	3
Well-Being	4	10
05. The seriousness in implementing waste management	18	72
Name	Files	References
01. Environmental Policy	14	24
02. General waste policy	6	8
03. EU Regulation	7	7
04. Not serious - A routine	4	10
06. The primary influencer in the understanding of the circular economy	0	0
Name	Files	References
01. EMF & McKinsey, CE100 Club member	17	25
02. Performance Economy - Prof Walter Stahel	3	5
03. Life-cycle Analysis	5	5

Name	Files	References
Cradle-to-Cradle - Braungart and McDonough	1	1
Name	Files	References
04. Lean Management, TQM, Six Sigma	4	4
05. Technological Advancement	1	1
06. Accenture	3	5
07. Waste Hierarchy	0	0
08. The Natural Capitalism	1	1
09. The Doughnut Economics	1	3
10. Resource Scarcity, Price Volatility, Global Recession	3	5
11. Waste Hierarchy	6	8
07. Views about the UN Sustainability programmes and the circular economy	24	72
Name	Files	References
01. Sustainability is an overarching concept	25	34
02. The circular economy is an overarching concept	4	7
03. No views on UN Sustainability and the circular economy	5	6
04. Sustainability and the Circular economy are similar	1	1
05. Mental models	3	7
08. Is the circular economy an evolution or a revolution	0	0
Name	Files	References
Evolution	27	32
Revolution	4	4
09. The politics of the circular economy	11	21
Name	Files	References
Politics in Government firms	21	110
Politics in IT firms	12	43
Politics within Auto firms	5	56

10. Limitations in practising the circular economy	27	348
Name	Files	References
Accounting challenges	5	12
Accounting challenges in Automotive industry	3	8
Brexit impact	4	12
CE Standards	8	21
Challenges for CE	8	22
Name	Files	References
Accounting challenges	1	3
challenges for digitalisation	1	4
concerns for collaboration	1	2
Name	Files	References
challenges for digitalisation	2	5
concerns for collaboration	1	2
Conflicting Interests in the Automotive industry	3	10
Consumption increase	1	2
Conundrum	21	72
Cultural	6	50
Design challenge	4	13
General Barriers that apply to CE as well	3	14
Investment	2	3
Materials sorting challenges for IT and Automotive sector	10	21
Negative impact on environment	4	8
11. Contentious issues reported in Government Agencies	31	223
Name	Files	References
1 The Politics of the circular economy term	18	34
2 Vested interest influencing the circular economy	20	53
3 Economics oriented Cartel. Competition Strategies	13	23
4 Dichotomy - Paradoxes	12	23

5 Wicked problems of circular economy	29	42
6 Gatekeeper issue	4	5
7 European Commission politics of circular economy	6	13
8 Participant's views about EMF	8	14
12. Causal mechanisms for CE in Automotive and IT firms	27	194
Name	Files	References
Causal mechanisms - reported by government agencies participants	11	40
Name	Files	References
Generative mechanisms	15	75
13. Components of the circular economy in IT and Automotive industry	10	28
Name	Files	References
Confidentiality-competitiveness	1	1
Customer focus	3	6
Dimensions of circular economy	13	42
Name	Files	References
Performance of materials	31	108
14. Gatekeeper issues faced by the researcher	4	6
Name	Files	References
Components of the circular economy in IT and Automotive industry	10	28
Name	Files	References
Confidentiality-competitiveness	1	1
Customer focus	3	6
Dimensions of circular economy	13	42

15. New information	12	85
16. Circular Economy in Europe	1	17
17. Recommendations	11	67
Name	Files	References
05. Improving waste management process	21	62
Sector recommendations ~~	1	23
The case for change	6	20
Name	Files	References
investment	2	3
Learning	6	24
18.Theoretical coding of responses from the participants of Automotive and IT firms	0	0
Name	Files	References
Capabilities, skill sets in CE environment in IT and Automotive industry	20	62
Name	Files	References
Competition in CE environment	4	18
Components of the circular economy	8	25
Critical Raw Materials List of raw materials that the European Union51 ~~regards as 'critical' as they are crucial to manufacturing in ~~Europe, but their supply chains are under threat due to increased demand and rarity. • Antimony • Beryllium • Cobalt •	3	4
Definition - Capability	10	67
Name	Files	References
Definition of resource	1	1
Definitions of Dynamic capabilities	6	25
Distinctiveness	15	97
Excerpts from Teece	2	18

Expert interviewees ~~Mark Turner, head of the chemical unit, BIS ~~Dame Fiona Reynolds, master of Emmanuel College, Cambridge University and Green Alliance chair ~~Stephen Tindale, research fellow, Centre for European Reform ~~Tom Burke, chairman, E3G ~~	1	1
Future markets	7	30
Growth- new approaches	7	21
How are DCs created and renewed	8	23
Impact of the circular economy understanding on the resources and capabilities	9	41
Linkages with CE	6	42
opportunities thrown by CE	5	18
Path dependencies	4	7
Position - Collaboration	2	53
Position - relationship	4	7
Position - reputation	2	2
Strategy as Enabler	6	15
Structure of the firm	4	9
Name	Files	References
VRIN ideas Automotive sector	9	42
Name	Files	References
Capabilities	8	35
Name	Files	References
DC- Sensing and Seizing	3	5
Resilience	1	5
Name	Files	References
Flexibility of materials for IT and Automotive sector	12	35
Inimitable	11	95
Non-substitutable	15	77
Rare	10	65
RBV model	4	15

Name	Files	References
RBV	2	2
Name	Files	References
Valuable	18	129
Name	Files	References
VRIN ideas IT industry	8	62
Name	Files	References
Characteristics of resource	3	11
Name	Files	References
Impact or Causality- resources and capabilities	6	14
Name	Files	References
Causal Mechanisms	5	11
Name	Files	References
automation	1	1
CE for marketing purposes	1	3
Economic reasons	1	2
EMF- role of charity	2	3
Me too	4	9
Morphogenetic Analysis	2	2
Policy reasons	1	2
Political reasons	1	1
Reasons to adopt CE	1	2
rethinking	1	1
Something else	0	0
Name	Files	References
Remanufacturing	2	3
repair	4	5
reuse	5	11

Time dimension	5	12
Name	Files	References
Competitiveness in IT and Automotive industry	9	46
Name	Files	References
3D Applications	4	9
3D improves functionality	3	7
3D processing	3	22
Combination plus recombination - Schumpeter	12	29
competition	6	9
Competitive Advantage	3	4
Continuous improvement	1	1
Design	8	16
Economics versus Engineering debate	1	2
Extended Producer Responsibility	3	4
First mover advantage	1	1
flexibility of processes	3	5
Flexible manufacturing	1	1
Ideas of Resource productivity	6	34
Innovation	5	7
Reengineering	1	2
Technology	7	16
Technology helping supply chain	4	8
Name	Files	References
Critical material	8	24
Inimitable	3	5
Non-substitutable	2	7
Rare	3	5
Utility	0	0
Valuable	8	45
VRIN impact	11	80

Main Themes (Third level)	0	0
The Seven Steps	0	0
Name	Files	References
1. About the industry	37	215
Name	Files	References
Automotive industry trends	15	48
Circular Economy in Europe	1	17
Collaboration in the Automotive industry	7	16
comparison with other countries	4	16
IT industry trends	7	23
New thinking in automotive industry	4	24
Name	Files	References
Processes	15	69
Name	Files	References
2. About the manager	54	80
3. About the firm	37	53
Name	Files	References
4. About the firm's understanding the circular economy	0	0
Name	Files	References
5. About the firm's practice of the circular economy	5	5
Name	Files	References
03. The firm practices or operationalises the circular economy as (Already discussed in the main list)	32	294
Name	Files	References

6. About the wastes	13	40
Name	Files	References
7. About the notion of profit	8	15
Name	Files	References
01. Mainstream = Revenues (minus) Costs	16	52
02. Value added to the economy Or, Change in accounting principles	8	20
03. Value in terms of the well-being of employees and future generations	11	27
Name	Files	References
Introduction	9	15
Name	Files	References
Relevance to the UK manufacturing industry	3	4

Appendix 16: Comparing the number of items coded at the node – 'The circular economy is' and representative references.

Table 7-5: Comparing the number of items coded at the node – The circular economy is'

Codes	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded
Nodes\\One List\\02. The circular economy is	14	438	9	68
Nodes\\One List\\02. The circular economy is\All- reduce, reuse, recycle, recover	42	42	18	18
Nodes\\One List\\02. The circular economy is\Alliance - Collaboration	1	1	1	1
Nodes\\One List\\02. The circular economy is\Distinct	94	94	10	10
Nodes\\One List\\02. The circular economy is\Entropy	10	10	2	2
Nodes\\One List\\02. The circular economy is\Green environment	6	6	5	5
Nodes\\One List\\02. The circular economy is\Lean Management, Six Sigma and Continuous Improvement	20	20	6	6
Nodes\\One List\\02. The circular economy is\Not clear and a Buzzword	88	132	40	50
Nodes\\One List\\02. The circular economy is\Not clear and a Buzzword\Buzzword - Complex	7	7	5	5
Nodes\\One List\\02. The circular economy is\Not clear and a Buzzword\Morale based	4	4	1	1
Nodes\\One List\\02. The circular economy is\Not clear and a Buzzword\Normal business practice	4	4	3	3
Nodes\\One List\\02. The circular economy is\Not clear and a Buzzword\The CE is an old concept	29	29	16	16
Nodes\\One List\\02. The circular economy is\Product Designing	3	3	1	1
Nodes\\One List\\02. The circular economy is\Resource Efficiency and or Resource Productivity	11	20	6	9
Nodes\\One List\\02. The circular economy is\Resource Efficiency and or Resource Productivity\Waste flows	4	9	3	6
Nodes\\One List\\02. The circular economy is\Resource Efficiency and or Resource Productivity\Waste flows\Deliver Value	5	5	3	3
Nodes\\One List\\02. The circular economy is\Strategy	10	19	7	14
Nodes\\One List\\02. The circular economy is\Strategy\Branding strategy	9	9	7	7

Codes	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded
Nodes\\One List\\02. The circular economy is\Technical Innovation plus New Business Models	6	77	2	16
Nodes\\One List\\02. The circular economy is\Technical Innovation plus New Business Models\New Business models	4	4	3	3
Nodes\\One List\\02. The circular economy is\Technical Innovation plus New Business Models\Technical Innovation	12	67	8	12
Nodes\\One List\\02. The circular economy is\Technical Innovation plus New Business Models\Technical Innovation\Automation	46	55	7	7
Nodes\\One List\\02. The circular economy is\Technical Innovation plus New Business Models\Technical Innovation\Automation\Digitalisation	9	9	1	1

Representative References coded at 'Not clear and a Buzz word'

<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\01. P01-A> - § 1 reference coded [100.00% Coverage]
Reference 1 - 100.00% Coverage
Circular Economy is a huge area, this is how we measure it. And actually that some of the challenges we have got, and I have got personally when I go to conferences to give a...(gap)... to tell a story, that is digestible...
<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\02. P02> - § 5 references coded [4.44% Coverage]
Reference 1 - 1.29% Coverage
But, if you've got a DNA of something that is inherently circular, you'd start thinking you know and maybe jumping on the bandwagon a little bit around circularity and how to sell your business as a circular business
Reference 2 - 0.65% Coverage
. Um, when we started, uh, sort of terming it a little bit more internally, circular business or circular economy, which is the -- the buzzword a little bit at the time. Uh, I don't think that went down quite as well.
Reference 3 - 0.22% Coverage
Well, the circular -- you know, in terms of, uh, phraseology, it's a-it's a -- it's a -- it's a great invention
Reference 4 - 2.28% Coverage
the circular economy is being -- as a term, is being used by anybody and everybody to describe -- I don't know, anything that they're doing, you know, you know, and whether it's, you know, reusing shoes or doing whatever.
Reference 5 - 2.28% Coverage

So yeah, it's an interesting phrase, I mean, we've appropriated it for our own names, um, as it, you know, well, itself I don't think it's changed most of the business as a -- as a term.
<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\05. P08> - § 2 references coded [1.99% Coverage]

Reference 1 - 0.78% Coverage

I mean there's a lot of buzz words floating around about sustainability

Appendix 17: Comparing the number of items coded at the node 'The seriousness in implementing waste management' along with representative references

Table 7-6 :Comparing the number of items and references coded at 'The seriousness in implementing waste management'

Codes	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded
Nodes\\One List\\05. The seriousness in implementing waste management	72	127	18	23
Nodes\\One List\\05. The seriousness in implementing waste management\01. Environmental Policy	30	30	14	14
Nodes\\One List\\05. The seriousness in implementing waste management\02. General waste policy	8	8	6	6
Nodes\\One List\\05. The seriousness in implementing waste management\03. EU Regulation	7	7	7	7
Nodes\\One List\\05. The seriousness in implementing waste management\04. Not serious - A routine	10	10	4	4

Representative References

<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\05. P08> - § 2 references coded [3.60% Coverage]

Reference 1 - 3.14% Coverage

We have an ISO 14001 certification, so environmental waste is managed in that way

<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\03. P04> - § 1 reference coded [0.12% Coverage]

Reference 2 - 0.47% Coverage

So, the environmental responsibility there for the woodlands, we keep that in good order.

<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\02. P02> - § 4 references coded [2.50% Coverage]

Reference 1 - 0.51% Coverage

Yes. So, we have, uh, we've got a global environmental management. Uh, all our -- all our plants are, um, globally, uh, ascribed to ISO 14001. So environmental management systems, we have a globally environmental manager, um, the metrics that the company set in 2011 were as well as, um -- so as energy, greenhouse gases, water, uh, waste, financial performance, uh, staff, uh--

Appendix 18: Comparison of the different influences on the understanding of the circular economy

Table 7-7: Comparing the number of items coded at the node 'The primary influencer…'

Codes	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\01. EMF & McKinsey, CE100 Club member	**25**	**25**	**17**	**17**
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\02. Performance Economy - Prof Walter Stahel	5	5	3	3
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\03. Life-cycle Analysis	5	6	5	6
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\03. Life-cycle Analysis\Cradle-to-Cradle - Braungart and McDonough	1	1	1	1
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\04. Lean Management, TQM, Six Sigma	4	4	4	4
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\05. Technological Advancement	1	1	1	1
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\06. Accenture	5	5	3	3
Waste Hierarchy				
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\08. The Natural Capitalism	1	1	1	1
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\09. The Doughnut Economics	3	3	1	1
Nodes\\One List\\06. The primary influencer in the understanding of the circular economy\10. Resource Scarcity, Price Volatility, Global Recession	5	5	3	3

Representative References for the highest number of items coded - EMF influence

<Files\\02. Inner Case Nest - Participants from the IT firms\\16. P18-A> - § 1 reference coded [1.04% Coverage]

Reference 1 - 1.04% Coverage'You know reading the, um, uh, Ellen MacArthur McKinsey Report, which was created for [Dabos? 00:06:38], which is probably one of the best summaries of circular economy that I've read. Uh, and then I followed up and I spoke to the El- Ellen MacArthur Foundation as well, um, and tried to get a really good understanding. This is going back to sort of 2012/13 actually maybe 2013, um, yeah, so.

<Files\\02. Inner Case Nest - Participants from the IT firms\\19. P49-A> - § 1 reference coded [100.00% Coverage]

Reference 1 - 100.00% Coverage

erm, materials management, you know, I mean circular…circularity is all about keeping value in the materials and the products. Or- or products first before materials. And I think, you know, the, er, Ellen MacArthur Foundation coined it very well. Erm, and erm, we- we aligned with their approach

Appendix 19: Comparing the number of items coded at the node - the notion of profit

Table 7-8:Comparing the number of items coded at different nodes at the notion of profit

Codes	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded
Nodes\\One List\\The Seven Steps\7. About the notion of profit	32	170	4	4
Nodes\\One List\\The Seven Steps\7. About the notion of profit\01. Mainstream = Revenues (minus) Costs	**65**	**65**	**4**	**4**
Nodes\\One List\\The Seven Steps\7. About the notion of profit\02. Value added to the economy Or, Change in accounting principles	33	33	4	4
Nodes\\One List\\The Seven Steps\7. About the notion of profit\03. Value in terms of the well-being of employees and future generations	40	40	4	4

Appendix 20: Representative Sample for references coded at the node – 'The notion of profit'

Name: The Seven Steps\7. About the notion of profit
<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\07. P30-A> - § 2 references coded [100.00% Coverage]
Reference 1 - 100.00% Coverage
: Yes. [laughs] what would be the notion of profit? The profit I would see from that is the wellbeing of the people
Reference 2 - 100.00% Coverage
. Um, commonly it's called printing money. Now, I know about quantitative easing, um, and, uh, that was a way of printing money but that money went into the pockets of banks, uh, rather than into the, um, wellbeing of the people. So, I think we need a… a complete rethink about the use of money as well as a complete rethink of, um, capitalism and our future as well.
<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\08. P32-A> - § 3 references coded [100.00% Coverage]
Reference 1 - 100.00% Coverage
: Oh, well, if the correct metrics of measurement were in place and they were associated with monetary value, carbon resource efficiency etcetera, then if there was a good job done of linking pound note value in taxation to carbon resource efficiency, number of times you've been round a circle, then I feel that would drive the profitability for the organizations in pound note terms.
Reference 2 - 100.00% Coverage
And the problem we've got is we tend to measure business success just in did it deliver a set of profit and loss and balance sheet figures, not did this company deliver loads of beneficial function to consumers and pleasure and enjoyment in a way that did not damage the wo- Earth's environment. We- we really haven't got that yet.
Reference 3 - 100.00% Coverage
So, there's profitability pound notes, but there's also, have I delivered loads of consumer benefits and they enjoy the benefit without us damaging the planet. We don't have a measure for that yet, but that would be a much more important profit than I made a few quid in the bank next year. If we're still able to do it in forty years, then that would be really an ethical profit, wouldn't it?
<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\10. P42> - § 4 references coded [100.00% Coverage]
Reference 1 - 100.00% Coverage
]. Mm. Yes, the first one, I mean I'm happy, I don't…I'm happy to be proven wrong. But I'm happy at the moment to work on the basis that notion of profit can be the same, but the way in which, erm, erm, profit is assessed has got to change.
Reference 2 - 100.00% Coverage
Right. So you have multidimensional, er, you know things that is emanating out of profit. So for the time being I think what you're doing is I agree to a lot…most of it, because right now if you touch profit you'll just be thrown out
Reference 3 - 100.00% Coverage
]. Mm. Absolutely, no, I'm completely with you- with you there entirely. And it's just that the rules for assessing profit and what you're allowed to make profit out of, have got to be better. They're rubbish at the moment. Erm, but I think that we can even with the rubbish set of rules we have at the moment, I think we can build a model that is more profitable than the conventional model
Reference 4 - 100.00% Coverage
Erm, but, er, ultimately a truly circular economy wouldn't have waste in my terms.
<Files\\02. Inner Case Nest - Participants from the IT firms\\14. P11-B> - § 1 reference coded [0.46% Coverage]
Reference 1 - 0.46% Coverage

¶420: Um, I think from a customer's perspective it can be very attractive, the- the, uh, Opex versus Capex type argument very attractive. Then-- but then they're just pushing [laughs] they're pushing the problem somewhere else. And- and I think that's quite-- it is quite difficult to work out for-- no matter what size company you are, it's quite hard. So I think that's- that's-- it- it- it can be overcome, but I think it is- it is difficult.

¶421:
<Files\\03. Outer Case Nest - Participants from the Government Agencies\\21. P13> - § 1 reference coded [3.02% Coverage]

Reference 1 - 3.02% Coverage

I think that a true circular economy should provide a- a high standard of living and acc- [sound of drilling] - access to, erm, you know, good services and we should all be as high up Maslow's Hierarchy of Needs as we can be, but profit extraction is usually done at the - you know, it's this notion about value.
So, in fact, I suppose profit could potentially be a facet of new value created. So, profit could be linked back to the- the- the systematic but sensible and sustainable extraction of primary resources. Cos as we talked about earlier, there's a lot of this stuff left in the ground. Er, there's a lot of this stuff left in the water. There's, er, you know, you - there's an increasingly large amount of potentially valuable resources like carbon dioxide in the air all around us. So, maybe there is some notion that profit should be- but profit should be reflected on resource extracted.
But again, it's- it's difficult. I- I come back to that equitable distribution of benefit. Profit is a tricky thing to nail down in a circular economy. And the pursuit of profit can lead to breaking loops, breaking circles, turning them back to linear mechanisms. And perhaps a wider rethink about what that- what that term means.
Maybe it would be better thinking in terms of not making a profit, but making value. Or not making a profit but maybe we need a new word, and that remuneration is based on how effective you are at preserving value than extracting value.
That's - I should've writ- I should write that down. That could be the, like, the last chapter of my book, if I ever write it [chuckles].
<Files\\03. Outer Case Nest - Participants from the Government Agencies\\24. P17-B> - § 1 reference coded [0.37% Coverage]
Reference 1 - 0.37% Coverage
: Yeah, simply going back to the indicator around gross value added and per unit of resources that you use. Yeah, so, yeah I don't have anything to add other than the classic definition of profit I'm afraid.
<Files\\03. Outer Case Nest - Participants from the Government Agencies\\29. P27> - § 1 reference coded [2.94% Coverage]
Reference 1 - 2.94% Coverage
. Um, you know, for me I-- on a personal level I can think about them and- and come up with solutions or po- potential models that are different that could work, but you're never going to achieve true circularity while the- the main motive is- is profit and- and the- the model is based upon exponential growth which isn't possible in a one planet scenario.[1,2]
<Files\\03. Outer Case Nest - Paricipants from the Government Agencies\\34. P40-A> - § 2 references coded [100.00% Coverage]
Reference 1 - 100.00% Coverage
Oh within- within a pros… well there's the prosperous Wales, erm, goal, erm, which [pause] I mean it- it- it all relates back to the well-being and happiness of individuals. Erm, whether that equates to financial, erm, happiness as being the one and only way of improving your well-being is- is a- is a matter for debate. Erm, the whole point of the well-being goals is to get a balance, erm, between, err, sort of healthy, environmental, social and economic well-being. Erm, and get a balance between all of them, not just, erm, focusing on one, you know, in terms of mon-

monetary gain. Erm, profit, erm, I mean we have a- we have a not for profit, erm, community enterprise running our water system for example, Dŵr Cymru. So, any profits are ploughed back into, erm, the system or are there for the benefit of the community. Erm, there's a whole lot of politics involved in this. I probably better not [burp? 31:10] and not get any further.

Reference 2 - 100.00% Coverage

Yeah, it's not, err, a subject that I'm expert on at all.

Annotations

[1] No proper understanding -

[2] c.f .to Nick Cliffe

Name: The Seven Steps\7. About the notion of profit\03. Value in terms of the well-being of employees and future generations

<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\07. P30-A> - § 2 references coded [100.00% Coverage]

Reference 1 - 100.00% Coverage

: Yes. [laughs] what would be the notion of profit? The profit I would see from that is the wellbeing of the people

Reference 2 - 100.00% Coverage

. Um, commonly it's called printing money. Now, I know about quantitative easing, um, and, uh, that was a way of printing money, but that money went into the pockets of banks, uh, rather than into the, um, wellbeing of the people. So, I think we need a… a complete rethink about the use of money as well as a complete rethink of, um, capitalism and our future as well

<Files\\02. Inner Case Nest - Participants from the IT firms\\12. P03-D - Main interview> - § 2 references coded [2.35% Coverage]

Reference 1 - 1.54% Coverage

¶113: Uh, obviously profits, um, it-it can be done in two ways. The- the- the, um, investment you spend in new people, gives you profit back. Uh, in other ways, uh, so- so let- let's say for sales. If you educate your sales staff correctly, if they follow the certain path, if you invest in them in one way and don't just beat them with a stick and say, "Sell, sell, sell." They will ret- give you a return of investments with- with sales. So therefore it gives the company profits. Without profit the company's dead, so we need to give a top-class service, and it's not just making money for the sake of making money, but that- and that's why it's number three in the- in the chain.

Reference 2 - 0.81% Coverage

¶114: Profits will feed back into the company. Will invigorate it. Will, uh, make it viable like a- a, you know, I said it before i- if there's no profits, the company doesn't work. So, at the end of the chain, there must be some kind of return but a- a th- th- the the profits is in two fold. One is with the staff, and one is with the monetary, uh, gains, yeah.

<Files\\02. Inner Case Nest - Participants from the IT firms\\13. P09-C> - § 2 references coded [1.07% Coverage]

Reference 1 - 0.25% Coverage

it would be for a business to earn more than it is spending, for its revenues to exceed its expenditure.

Reference 2 - 0.82% Coverage

okay. I think I'll go back to that point I talked about, um, about accounting within companies and actually there needs to be, um, I suppose a mind shift, a paradigm change in- a shift in how we view materials in use, in stocks and the value attached to it, um, so I think, I think more could be done for accounting for circular economy perhaps.

<Files\\02. Inner Case Nest - Participants from the IT firms\\17. P33-B> - § 2 references coded [0.82% Coverage]

Reference 1 - 0.41% Coverage

¶130: erm, as we said earlier one, productivity is a measure of the profitability, in effect, because if one person can make one car, one person can make two cars, he's now suddenly fifty percent more productive. Er, that makes him more profitable, or in a world of, er- er, harsh economics, it can make him survivable against the competition which is p- which is cheaper.

Reference 2 - 0.40% Coverage

¶135: the brand value of Siemens is quite high. So, therefore, when a cust- when a factory is carved out, it can o- it can become more efficient just by being carved out, because the Siemens overhead of the brand is quite expensive. However, the value of that brand is lost. So, if it just- if it's not called Siemens anymore, then maybe its markets are limited.

<Files\\02. Inner Case Nest - Participants from the IT firms\\18. P45-B> - § 1 reference coded [0.67% Coverage]

Reference 1 - 0.67% Coverage

¶182: **Respondent**	[24:18]. So profit's really important, isn't it obviously, for if you run a business. And so we cannot get away from- from that. But, erm, and I haven't seen any research on this, but I- but I'm willing to bet the numbers stack out. Is I believe if you- if you really measure the profitability of a true circular economy, I think it's greater than the profitability of traditional manufactured products. I think if you…

<Files\\03. Outer Case Nest - Participants from the Government Agencies\\22. P15> - § 2 references coded [1.93% Coverage]

Reference 1 - 0.25% Coverage

Well, some of the existing providers of circular economy solutions are profit maximisers of course.

Reference 2 - 1.68% Coverage

It depends on who you are. If you're the third sector, it's not for profit, you've got to cover you try and cover your costs. Now whether that's through the sale of items or whether it's through, , grants or a combination of both, they've got to cover the cost to keep things going. Now some, , charities will draw on voluntary labour now and again, but it's quite difficult to manage on a permanent predictable basis, and a circular economy needs predictability, needs guarantees and, , particularly where, , you're moving into, , the modern economy. , there's a gap where

between the not for profit and profit maximisation, , where you've the- the two sides come together, the public sector wants, no profit to be made by the contractor, but if you've got investment you need profit to repay the investment. So it's needs to be a balance really

<Files\\03. Outer Case Nest - Participants from the Government Agencies\\29. P27> - § 2 references coded [3.46% Coverage]

Reference 1 - 2.94% Coverage

But the big problem is the 'E' word, we still have a linear economy. You- you won't have proper circularity without a linear- without a linear economy becoming a circular economy and a circular economy is not the model that we've got now. So someone needs to bite the bullet and- and say what's the other model. It might not be shareholder capitalism, you know, and- and those- those are the big questions that really need to be tackled but they're outside of our remit. Um, you know, for me I-- on a personal level I can think about them and- and come up with solutions or po- potential models that are different that could work, but you're never going to achieve true circularity while the- the main motive is- is profit and- and the- the model is based upon exponential growth which isn't possible in a one planet scenario.[1,2]

Reference 2 - 0.53% Coverage

Well, I'd-- personally I think GDP as a- a measure of anything is reaching its sell by date. Um, a lot of economists are saying now that we should be looking at well-being models, uh, or low and no very growth, you know, very low and no growth models. Uh, Finland's already experimented with a national wage.

<Files\\03. Outer Case Nest - Participants from the Government Agencies\\30. P28-A> - § 3 references coded [7.83% Coverage]

Reference 1 - 2.34% Coverage

Um, um, I find it hard to answer that question right now. Give me some more to think about it and maybe I can answer you later. But, um, I just mentioned, um, the quality of our soil, and, um, we had in the- in the agriculture, uh, farms and farms get bigger and bigger, so. And also, uh, in the diary sector there- there cames more and more cows- cows because all the farmers, um, learned at school, uh, when they were at school that you- that growth is better, so more and more cows means more and more income. So when you have more and more cows, you have more and more, um, what is it, dung?

Reference 2 - 2.54% Coverage

Um, um, that's also, um, uh, consider that you al- also consider the- the- the- the negative cost. So that you don't only look at profit like in the- the- the example of the milk factory, but that you also, uh, capitalize the- the negative effects, so of, um, the- the- the cost of the- the cow dung and- and how you get rid of that, the loss of the quality of the soil. So you should have, uh, uh, methodics on how you, uh, measure that- that negative effectives, and then you have, uh, uh, uh, cost, um, and data analyse,[3]

Reference 3 - 2.95% Coverage

Yes. So in a circular economy you have, uh, more and more cost benefit analysis and you know how to measure, uh, uh, negative effectives. So- so, uh, and- and then you- you can make your mind up, so is it really worth to do things. So that's- that's for me, uh, uh, important and also, um, uh, a well- well-being of people, how you, um, how you measure that. So, um, it- it's not only, uh, what people earn, but it's also how- how people to live in a province that's- that's-- and- and how they are-- and do they have time to do some voluntary work in the- in the city they of- of town they live. That kind of things you should in the- in the most ideal way you should, uh, measure and- and- and that's also important. So it's- it's more than just earn money.[4]

<Files\\03. Outer Case Nest - Participants from the Government Agencies\\31. P29> - § 5 references coded [100.00% Coverage]

Reference 1 - 100.00% Coverage

Interviewer: So, what do you understand by profit?

Reference 2 - 100.00% Coverage

Interviewee: The money, the revenue. [laughs]

Reference 3 - 100.00% Coverage

[00:23:55]Interviewer: Very good. So, what is… so, from- this is the notion, that profit is revenue.
Reference 4 - 100.00% Coverage
Interviewer: Okay? So, what should be the notion of profit in circular economy environment?
Reference 5 - 100.00% Coverage
That's hard to answer question with the profit. Well, the profit in the circular economy should not be considered maybe as just you know raw, raw money. Not just raw money. It should be considered maybe through the benefits, not just the money because when you get to develop the circular economy and get it to the people, okay so maybe some may have profit from this, from this, from this and that, that's not good. Not good way. Focus on the benefits. Of course, there is always a money and always a profit in the front of that but not to be the focus.[5]
<Files\\03. Outer Case Nest - Participants from the Government Agencies\\34. P40-A> - § 4 references coded [100.00% Coverage]
Reference 1 - 100.00% Coverage
Oh within- within a pros… well there's the prosperous Wales, erm, goal, erm, which [pause] I mean it- it- it all relates back to the well-being and happiness of individuals. Erm, whether that equates to financial, erm, happiness as being the one and only way of improving your well-being is- is a- is a matter for debate. Erm, the whole point of the well-being goals is to get a balance, erm, between, err, sort of healthy, environmental, social and economic well-being. Erm, and get a balance between all of them, not just, erm, focusing on one, you know, in terms of mon-monetary gain. Erm, profit, erm, I mean we have a- we have a not for profit, erm, community enterprise running our water system for example, Dŵr Cymru. So, any profits are ploughed back into, erm, the system or are there for the benefit of the community. Erm, there's a whole lot of politics involved in this. I probably better not [burp? 31:10] and not get any further.
Reference 2 - 100.00% Coverage
Yeah, it's not, err, a subject that I'm expert on at all.
Reference 3 - 100.00% Coverage
Forty six indicators, yeah.
Reference 4 - 100.00% Coverage
Yeah, they're statutory. They're called the national indicators…
Name: Nodes\\One List\\The Seven Steps\7. About the notion of profit\02. Value added to the economy Or, Change in accounting principles
<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\10. P42> - § 5 references coded [100.00% Coverage]
Reference 1 - 100.00% Coverage
The only difference I would have with the general notion of profit is that [pause] erm, I think that profit, erm, should reflect the value added to society.
Reference 2 - 100.00% Coverage
]. Mm. Yes, the first one, I mean I'm happy, I don't…I'm happy to be proven wrong. But I'm happy at the moment to work on the basis that notion of profit can be the same, but the way in which, erm, erm, profit is assessed has got to change.
Reference 3 - 100.00% Coverage
Right. So you have multidimensional, er, you know things that is emanating out of profit. So for the time being I think what you're doing is I agree to a lot…most of it, because right now if you touch profit you'll just be thrown out
Reference 4 - 100.00% Coverage
]. Mm. Absolutely, no, I'm completely with you- with you there entirely. And it's just that the rules for assessing profit and what you're allowed to make profit out of, have got to be better. They're rubbish at the moment. Erm, but I think that we can even with the rubbish set of rules we have at the moment, I think we can build a model that is more profitable than the conventional model
Reference 5 - 100.00% Coverage
Erm, but, er, ultimately a truly circular economy wouldn't have waste in my terms.
<Files\\02. Inner Case Nest - Participants from the IT firms\\13. P09-C> - § 2 references coded [1.07% Coverage]
Reference 1 - 0.25% Coverage

it would be for a business to earn more than it is spending, for its revenues to exceed its expenditure.

Reference 2 - 0.82% Coverage

okay. I think I'll go back to that point I talked about, um, about accounting within companies and actually there needs to be, um, I suppose a mind shift, a paradigm change in- a shift in how we view materials in use, in stocks and the value attached to it, um, so I think, I think more could be done for accounting for circular economy perhaps.

<Files\\02. Inner Case Nest - Participants from the IT firms\\15. P14-C> - § 1 reference coded [1.43% Coverage]
Reference 1 - 1.43% Coverage

¶115: Um, I think there is-- well, I think I wouldn't use the term profit. I think I'd use the term value. I think there is- there is huge amounts of value to be gained, um, from the circular economy. There's huge amounts of value to be gained from what we currently waste, um, and I think the more that we do that the more that we can, um, the more that we can create profit for ourselves. I mean that would be the- the profit would be the difference between the kind of value and the cost of you know, reclaiming that value.[1]

<Files\\02. Inner Case Nest - Participants from the IT firms\\16. P18-B> - § 2 references coded [2.13% Coverage]
Reference 1 - 0.79% Coverage

¶148: So, um, the- the, um, the notion of profit, profit in- in a circular economy has a, um, a much longer life. So you- you're discounted cash flows would be considerably longer, um, than you would expect that a traditional product lifecycle. So I- I don't think the circular economy is going to require any different principles of- of accounting for profit. It's just they'll be different- they'll be extra lines.

Reference 2 - 1.34% Coverage

¶149: Um, let me think whether there would be anything different. Um, no, I don't- I don't- I mean to be honest in- in most P&Ls you do not, um, pay any attention to the- the recycling. So if you're doing a- a P&L for a pro- product, when it gets to the end of it, it's like zero, it's worth nothing, which is never correct, cos it's either going to cost you something to dispose of it, or it's gonna cost- th- there's a profit associated with its reuse. So it's very interesting th- th- um, you know, what is the terminal value of a product. Um, the- that challenges the terminal value of a product, um, and that would make a completely different business case for the- for the, uh, for the product.

<Files\\03. Outer Case Nest - Participants from the Government Agencies\\22. P15> - § 2 references coded [1.93% Coverage]

Reference 2 - 1.68% Coverage

It depends who you are. If you're the third sector, it's not for profit, you've got to cover you try and cover your costs. Now whether that's through the sale of items or whether it's through, , grants or a combination of both, they've got to cover the cost to keep things going. Now some, , charities will draw on voluntary labour now and again, but it's quite difficult to manage on a permanent predictable basis, and a circular economy needs predictability, needs guarantees and, , particularly where, , you're moving into, , the modern economy. , there's a gap where between the not for profit and profit maximisation, , where you've the- the two sides come together, the public sector wants, no profit to be made by the contractor, but if you've got investment you need profit to repay the investment. So it's needs to be a balance really

<Files\\03. Outer Case Nest - Participants from the Government Agencies\\24. P17-B> - § 4 references coded [5.71% Coverage]

Reference 1 - 1.90% Coverage

: So, yeah, the way we frame the opportunity I think is key and with resource productivity we can talk about profitability.

Reference 2 - 3.03% Coverage

So, a lot of it is about making the case, demonstrating that customers want this and that there is a profit to be made through this, because going in and telling people that if they sell less they'll make more money, it's not a natural conversation.[2]

Interviewer: Right, okay, interesting and since this new guys...you know, firms the innovative firms are coming into the market, so what are the kind of entry barrier they're facing to circular economy environment?

Interviewee: So, a lot of that will be about funding models --[3,4]

Reference 3 - 0.37% Coverage

: Yeah, simply going back to the indicator around gross value added and per unit of resources that you use. Yeah, so, yeah I don't have anything to add other than the classic definition of profit I'm afraid.

Reference 4 - 0.40% Coverage

Yeah, so for me it would be around that getting that growing awareness around resource productivity, so getting people not just to look at labour but also to look at their profit relative to the amount of material that they bought.[5]

<Files\\03. Outer Case Nest - Participants from the Government Agencies\\25. P20> - § 2 references coded [1.88% Coverage]

Reference 1 - 0.26% Coverage

I think this is exactly same as my notion of profits before.

Reference 2 - 1.61% Coverage

I think so. Its still a producer making something, service or product, and-- I mean, your way of accounting for profits might need to change, and we know that there are barriers around for example; products, services, business models where you usually large amounts of capital stock is seen a liabilities, rather than, you know, something-- it's a beneficial thing which generate in income, and so we know that that needs to be rethought if this, you know, models aren't going to be seen by traditional accounting as sort of, you know, dreadful things that lead to huge liabilities, but I don't know if I really thought about it.

Annotations

1 Cf. response from Nick Cliffe- Innovate UK

2 Answers RQ 2 and 3

3 Answers RQ2- Funding is key for innovative firms and disrupters. This actually gives an idea the current accounting and funding methods needs upgrading or changing. It impact the resources and capabilities

4 Answers RQ2- Funding is key for innovative firms and disrupters. This actually gives an idea the current accounting and funding methods needs upgrading or changing.

5 Capitalist thinking

<Files\\03. Outer Case Nest - Participants from the Government Agencies\\Secondary data from Government Agencies\\Future Generations Act 2015-46 National indicators> - § 2 references coded [34.14% Coverage]

Reference 1 - 5.70% Coverage
¶13: The “national indicators” 1. Percentage of live single births with a birth weight of under 2,500g. 2. Healthy life expectancy at birth including the gap between the least and most deprived.
¶14: 3. Percentage of adults who have fewer than two healthy lifestyle behaviours (not smoking, healthy weight, eat five fruit or vegetables a day, not drinking above guidelines and meet the physical activity guidelines).
¶15: 4. Levels of nitrogen dioxide (NO_2) pollution in the air.
¶16: 5. Percentage of children who have fewer than two healthy lifestyle behaviours (not smoking, eat fruit/vegetables daily, never/rarely drink and meet the physical activity guidelines).
¶17: 6. Measurement of development of young children. 1 / 3
Reference 2 - 28.43% Coverage
¶20: 9. Gross Value Added (GVA) per hour worked (relative to UK average). 10. Gross Disposable Household Income per head. 11. Percentage of businesses which are innovation-active. 12. Capacity (in MW) of renewable energy equipment installed. 13. Concentration of carbon and organic matter in soil. 14. The Ecological Footprint of Wales. 15. Amount of waste generated that is not recycled, per person.
¶21: 16. Percentage of people in employment, who are on permanent contracts (or on temporary contracts, and not seeking permanent employment) and who earn more than 2/3 of the UK median wage.
¶23: 18. Percentage of people living in households in income poverty relative to the UK median: measured for children, working age and those of pension age.
¶24: 19. Percentage of people living in households in material deprivation. 20. Percentage of people moderately or very satisfied with their jobs. 21. Percentage of people in employment.
¶25: 22. Percentage of people in education, employment or training, measured for different age groups.
¶26: 23. Percentage who feel able to influence decisions affecting their local area.
¶27: 24. Percentage of people satisfied with their ability to get to/ access the facilities and services they need.
¶28: 25. Percentage of people feeling safe at home, walking in the local area, and when travelling.
¶29: 26. Percentage of people satisfied with local area as a place to live.
¶30: 27. Percentage of people agreeing that they belong to the area; that people from different backgrounds get on well together; and that people treat each other with respect.
¶31: 28. Percentage of people who volunteer. 2 / 3
¶32: 29. Mean mental well-being score for people. 30. Percentage of people who are lonely. 31. Percentage of dwellings which are free from hazards.
¶33: 32. Number of properties (homes and businesses) at medium or high risk of flooding from rivers and the sea.
¶34: 33. Percentage of dwellings with adequate energy performance.
¶35: 34. Number of households successfully prevented from becoming homeless per 10,000 households.
¶36: 35. Percentage of people attending or participating in arts, culture or heritage activities at least three times a year.
¶37: 36. Percentage of people who speak Welsh daily and can speak more than just a few words of Welsh.
¶38: 37. Percentage of people who can speak Welsh. 38. Percentage of people participating in sporting activities three or more times a week.
¶39: 39. Percentage of museums and archives holding archival/heritage collections meeting UK accreditation standards.
¶40: 40. Percentage of designated historic environment assets that are in stable or improved conditions.
¶41: 41. Emissions of greenhouse gases within Wales.
¶42: 42. Emissions of greenhouse gases attributed to the consumption of global goods and services in Wales.
¶43: 43. Areas of healthy ecosystems in Wales. 44. Status of Biological diversity in Wales.
¶44: 45. Percentage of surface water bodies, and groundwater bodies, achieving good or high overall status.
¶45: 46. The social return on investment of Welsh partnerships within Wales and outside of the UK that are working towards the United Nations Sustainable Development Goals.

Annotations

[1] No proper understanding -

[2] c.f. to Nick Cliffe

[3] Notion of profit - CF Hugo Spowers - 'Full- cost accounting' internalize the cost" And at the moment business le…er, does it's level best to externalize cost and in internalize reward. And my…so my only indifference is that I believe that there should be a full cost accounting basis"

[4] Wellbeing of people - cf. Andy Rees

[5] RQ3- profit should not be just revenue but what benefits it gives to the society.

Reference 2 - 0.24% Coverage

¶121: Schumpeterian profits (as the extra profits of the classical economists) are a transitional phenomenon to be traced
¶122: back to cost differentials between different methods of production used simultaneously. They are not due to the “scarcity” of capital, as marginal productivity theory maintains.

Annotations

[1] Standardization

[2] Growth through less consumption

[3] Answers RQ2 & 4- There is big gap in tacking CE - while the real metrics to measure growth and profit have not changed, then how can we expect that the processual change to have an impact . In order to change people's behavior first of all the corporates needs to change their notion of profit. This seems that Capitalism mind-set is being patched on a concept that is heterogeneous.

[4] This is a very interesting comment - this follows from the Sustainability agenda - This is touching the tip of an iceberg really - cause of slow uptake of circular economy and Sustainability being pushed down the throats of businesses through legislation - this solution is not long term and short lived - because businesses do not do this out of choice but compulsion. In my opinion anything is loaded will have short life. And we are seeing this very well in the case of SDGs and CE.

[5] Answers the causality - his bid to portray or justify 6% profit margin that remanufacturers make.

[6] This gives answers to RQ3 and RQ4 - it will impact resources and capabilities because resources and capabilities i.e., less resources and more capabilities (more labour). Does labour then becomes valuable; value here means abstract labour, crystallized as commodity; and “… the magnitude of the value of any article is … the amount of [abstract] labour … necessary for its production” (Marx, 1867: 129).

[7] Counter Keynesian model - in fact moving towards heterodox economics.

[8] Causal mechanism under play (possibly??) - He tries to clarifies his stand in a bid to stay clear from not siding with anti-capitalist. Delinking his enterprise and thinking from not making money as that drives capital flow into business and keeps investors interested.

[9] Answers RQ1- competitive nature - meaning needs distilling- kind of new thinking.

[10] This is also Schumpeter idea of creative destruction!!

[11] Discussion point - you don’t want to change the notion of profit but want to change everything else, then how objectives of wellbeing, equitable distribution of wealth.

Appendix 21: Comparing participants views about UN Sustainability and the circular economy

Table 7-9: Comparing the number of items coded at the node 'Views about UN Sustainability and the circular economy

Codes	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded
Nodes\\One List\\07. Views about the UN Sustainability programmes and the circular economy\01. Sustainability is an overarching concept	34	34	25	25
Nodes\\One List\\07. Views about the UN Sustainability programmes and the circular economy\02. The circular economy is an overarching concept	7	7	4	4
Nodes\\One List\\07. Views about the UN Sustainability programmes and the circular economy\03. No views on UN Sustainability and the circular economy	6	6	5	5
Nodes\\One List\\07. Views about the UN Sustainability programmes and the circular economy\04. Sustainability and the Circular economy are similar	1	1	1	1
Nodes\\One List\\07. Views about the UN Sustainability programmes and the circular economy\05. Mental models	7	7	3	3

Representative references for the highest number of item coded

<Files\\01. Inner Case Nest - Participants from UK Automotive firms\\01. P01-A> - § 2 references coded [100.00% Coverage]

Reference 1 - 100.00% Coverage

well sustainability covers everything

Reference 2 - 100.00% Coverage

Well, I think sustainability as I say now, is such a broadly used term it is not just linked to environmental initiatives, it's... it is linked to just about any initiative that you could think about in a business. Circular economy is is a really a subset in a way of that because it is driving that circular loops, so something more specific, focused

<Files\\02. Inner Case Nest - Participants from the IT firms\\15. P14-A> - § 1 reference coded [2.62% Coverage]

Reference 1 - 2.62% Coverage

Um, so for me, um, circular economy is one aspect of sustainability.