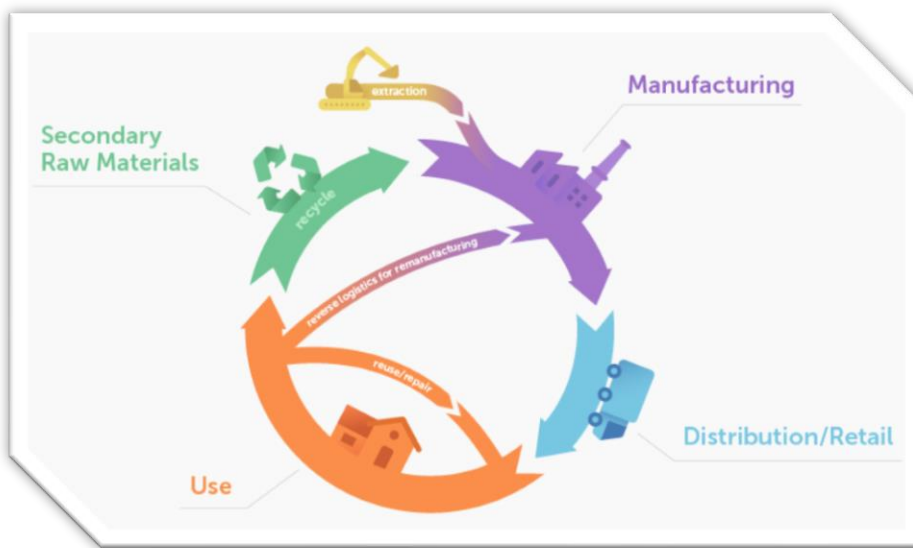


Use of circular economy models to improve the competitiveness of Manufacturing SME's – research proposal.



Understanding the opportunities and challenges that come with implementing a circular economy model in Manufacturing SMEs, while remaining competitive in the global market is of vital importance for the survival of the company, for its supply chain and for the society it serves and belongs to (Singh, Chakraborty et al. 2018).

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Introduction

The manufacturing sector is a significant contributor to the global economy, but it also has a significant impact on the environment (Korhonen, Honkasalo et al. 2018). Traditional manufacturing methods are often linear, starting from the extraction of raw materials, production of the equipment and goods, and disposal of waste. This approach is unsustainable for the future – short or long term, leading to environmental deterioration and to the depletion of natural resources. Therefore, a novel approach to manufacturing is needed, one which is more sustainable and circular in nature.

Circular economy (CE) is an approach to economic progress that is both regenerative and restorative by design (Kirchherr, Reike et al. 2017). Its aim is to keep goods, components, and materials in use for as long as possible, reduce waste and pollution as much as possible, and restore natural eco-systems. The circular economy is based on the principles of design for circularity, resource efficiency, waste minimization, and closed-loop systems. The circular economy offers a significant opportunity for manufacturing SMEs to reduce their environmental impact, increase resource efficiency, and improve their bottom line. In their work titled: ‘‘The future of the circular economy and the circular economy of the future’’ - 2020, Rodríguez, Pomponi et al, identify eight schools of thought that have impacted on how the concept of CE has evolved to this day. Starting from the late 1960’s with the concept of Cowboy (linear) versus Spaceman (circular) economies, looking at the natural world through biomimicry and natural capitalism. Other concepts being presented are Cradle to cradle (in opposition to cradle to grave approach – again linear), blue and performance economy, industrial ecology, and regenerative design (Rodríguez, Pomponi et al. 2020).

This essay discusses the concept of circular economy and its application in manufacturing SMEs. It highlights the benefits and challenges of adopting a circular economy approach and suggests strategies for overcoming these challenges.

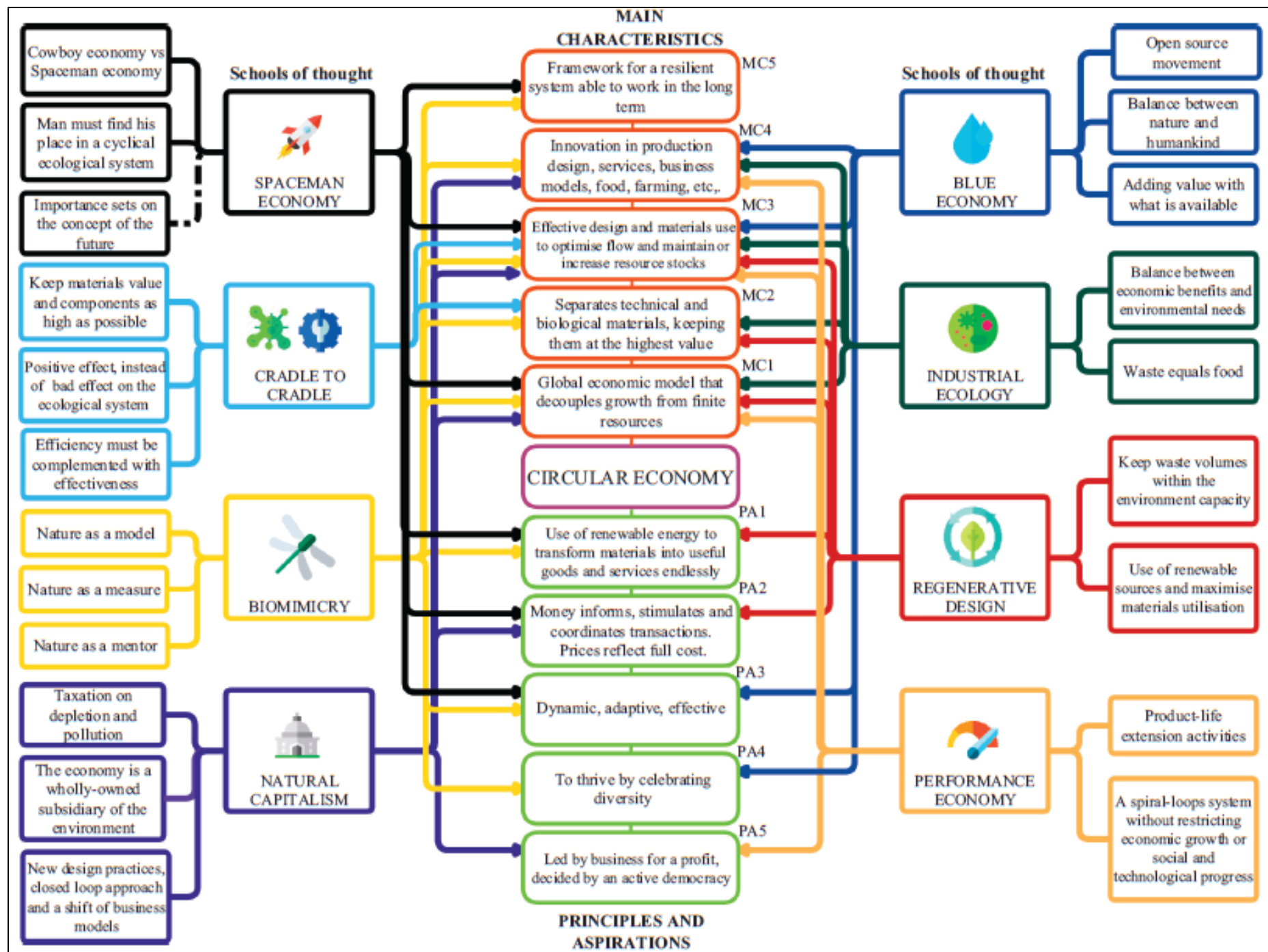


Figure 1 - Schools of Thought on CE - (Rodríguez, Pomponi et al. 2020)

Background, Aims and Objectives

The purpose of the study is to understand the opportunities and challenges that come with implementing a circular economy model in Manufacturing SMEs, while remaining competitive in the global market.

The target company selected for undertaking this research is a manufacturing SME, within the supply chain, currently providing bespoke lifting equipment in three different energy sectors: Oil & Gas, Nuclear and Renewables. Being in the supply chain (tier 1 and tier 2 supplier rank- see figure 2) presents a challenge for the SME (Rizos, Behrens et al. 2016) , because it must rely on the organisations below its tier to participate in the implementation of CE concepts and/or identify suitable alternatives that may already be practicing a form of circular economy (Ünal, Urbinati et al. 2019). The company can then bolster its appeal to current and potential new clients by presenting this in-vogue economic model, which, the Contracting companies may in turn use to their advantage when it comes to meeting their corporate socio-economic responsibility report statements (Friant 2021).

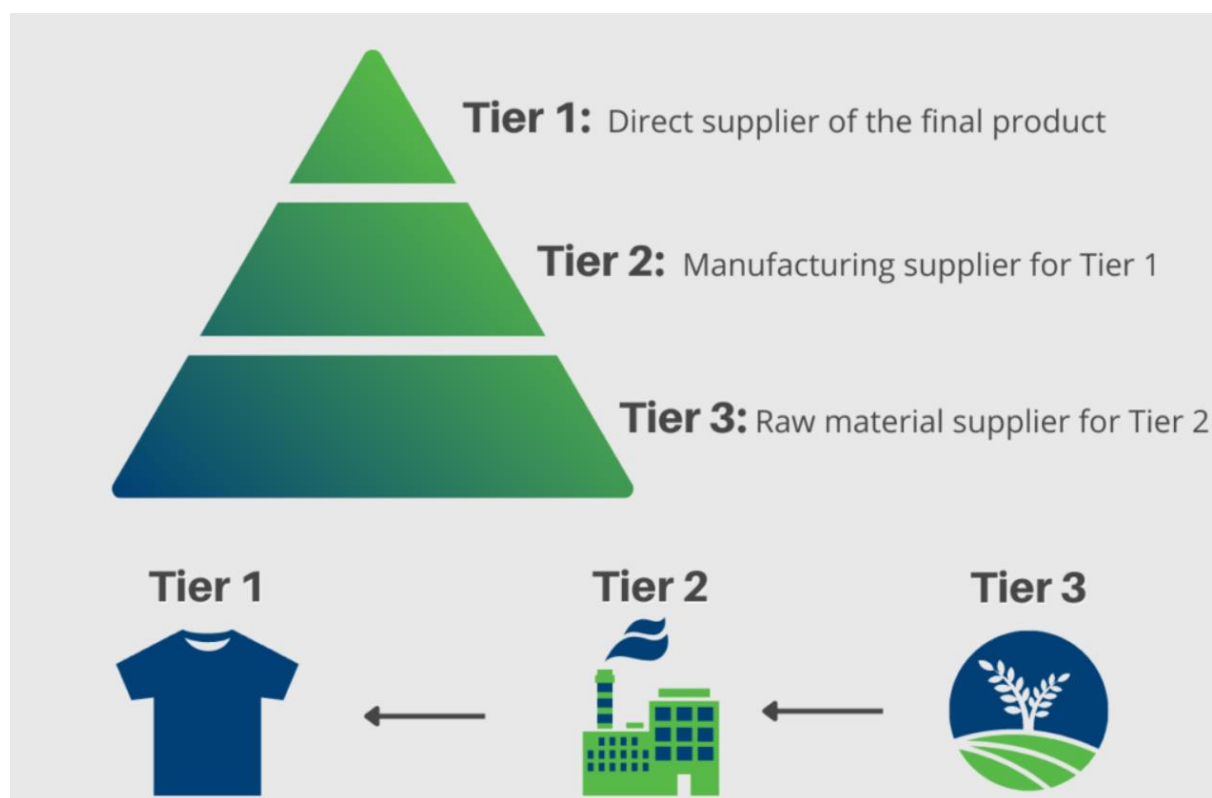


Figure 2 - Tiered supply chain diagram (Judge 2022)

SMEs are becoming more conscious of the benefits from circularity and enhanced resource efficiency, whether it be from lowering material costs, seeking competitive advantages, and tapping new markets. (Rizos, Behrens et al. 2016)

At the same time, however, SME's perennial challenges of the lack of financial and/or technical resources can become obstacles in the company's transition to CE. Both the benefits and challenges are presented in the next section.

The aims and objectives of the research are divided in two categories and then into further sub-groups. The methods section of the proposal goes into further detail regarding these aims. They are:

1. Active objectives of the research – these aims represent the active part of the research being undertaken.

- a. Short-term project (up to 6 months) – digitization of all components stock across the business and making use of Industry 4.0 technologies to identify and categorise existing material suitable to be integrated into current and future projects.

The purpose of this research is to use the existing stock, evaluated by the business owners at over £ 1million in the management accounts, to bring tangible value into the business and to reduce use of new made raw materials (Ünal, Urbinati et al. 2019), reducing the carbon footprint of the business.

- b. Medium-term project (up to 3 years) – Investment in education and upskilling of workforce while effecting organisational culture change – “the sum of the values, beliefs, practices, and behaviours that contribute to the social and psychological environment of an organization” (ATD 2023) by implementing and enforcing CE-centric policies and procedures.

- c. Long-term project (3 to 5 years) – The establishment of a complete circular economy supply chain, fully embracing and respecting the implementation of CE procedures cascaded down throughout the entire chain. The entire supply chain can be traced through blockchain technology (De Giovanni 2022).

2. Passive improvements enacted by the undertaking of the main objectives.

- a. Reputation enhancement with existing and prospective clients
- b. Restructuring of the Goods in – Stores -Despatch department – This will meet requirements highlighted in recent client audit.
- c. Opening new avenues to do business by offering our products as a service where suitable (non-nuclear projects) or by offering clients a reverse logistics option at the end of an equipment's life-cycle – cradle to cradle school of thought. (Rodríguez, Pomponi et al. 2020)

Benefits and Challenges

Specific benefits may emerge for SMEs in implementing CE models.

1. CE practices can lead to cost savings through resource efficiency, waste reduction, and increased reuse and recycling of materials. (Singh, Chakraborty et al. 2018)

Companies can employ policies like life extension for equipment, remanufacturing, and recycling, SMEs can reduce material costs, better resource utilization and, in so doing, enhance their profits.

2. CE models can increase the competitiveness of SMEs by creating new business opportunities. For instance, SMEs can establish innovative business models such as product-as-a-service (Ellen MacArthur Foundation 2013), sharing economy, and common spending, which can create surplus revenue streams (EU Environment 2014) and promote customer loyalty. Circular economy practices can also advance innovation and fuel product and practice developments, leading to new market prospects and competitive advantages.
3. Circular economy models can help SMEs decrease their environmental effect and add to sustainable development goals (Ormazabal, Prieto-Sandoval et al. 2018). By curtailing waste production, greenhouse gas emissions, and other environmental pollutants, SMEs can correct their environmental performance, conform with regulatory conditions, and bolster their reputation as environmentally responsible businesses.

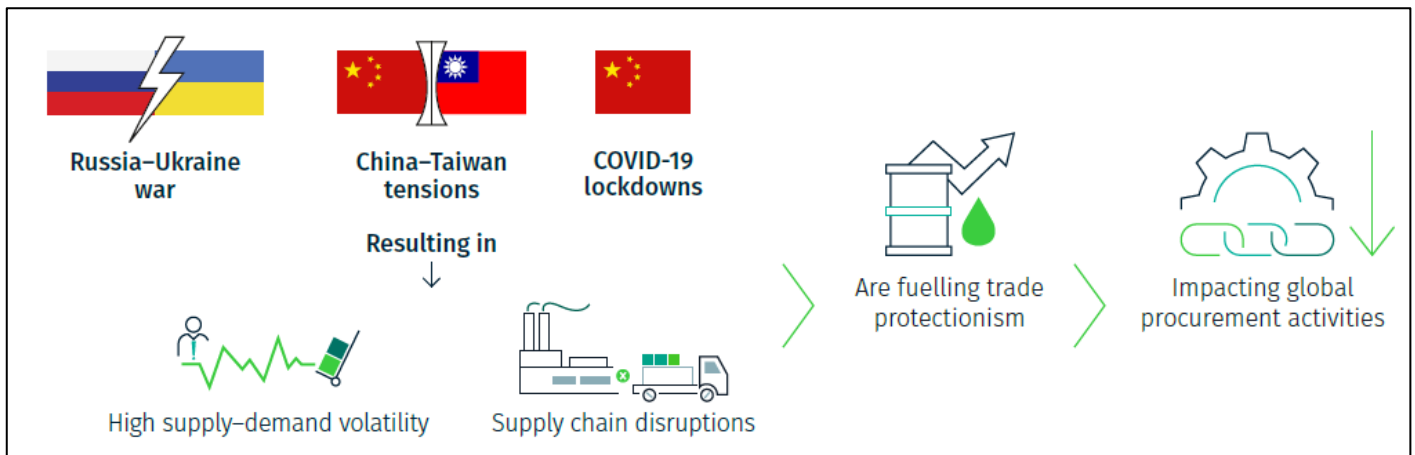


Figure 3 - Rising Trade Protectionism (*TheSmartCube.com* 2023)

Small and medium-sized enterprises (SMEs) face various challenges when effecting a circular economy approach (Jaeger, Upadhyay 2020). Some of the key challenges include:

1. Lack of awareness and understanding: Many SMEs may not be completely mindful of the model of circular economy and its potential benefits. They may not understand how circular economy values can be applied in their specific industry or business model. (Rizos, Behrens et al. 2016)
2. Reduced resources and facility: SMEs often have limited commercial, specialist, and human resources to invest in the required infrastructure and tools to execute circular economy practices. Implementing circular economy processes may require upfront investments, such as upgrading production processes, implementing waste management systems, or starting reverse logistics (Ünal, Urbinati et al. 2019), which can prove demanding for SMEs with constrained budgets.
3. Regulatory and policy barriers: Existing regulations and policies may not always support the adoption of circular economy practices (Bonciu 2014) (Singh, Chakraborty et al. 2018). SMEs may face regulatory barriers, such as permits,

certifications, and norms, which can pose challenges in applying circular economy processes. Contradictory or unclear policies related to waste management, product design, and recycling can also generate uncertainties for SMEs.

4. Supply chain complexities: SMEs often operate within complex supply chains, and implementing circular economy practices may require cooperation and coordination with multiple participants (Stuetermann 2019). SMEs may face challenges in connecting with suppliers, customers, and collaborators in circular economy projects, as well as managing the difficulties of reverse logistics, waste collection, and material recovery.
5. Market demand and user behaviour – See figure 3: The demand for circular economy products and services may not be extensive, and consumer conduct may not constantly favour circular economy principles (Friant 2021). SMEs may face challenges in finding a market for circular products, convincing clients to accept circular products or services, and successfully communicating the value proposition of circular economy methods to customers.
6. Technical and operating obstacles: Implementing circular economy practices may require SMEs to adopt modern technologies, redesign products or procedures, and reskill their employees. These technical and operational changes may pose challenges in terms of expertise, skills, and knowledge required for implementation (EU Environment 2014).
7. Economic incentives and business models: SMEs may face challenges in classifying and accessing financial incentives (Singh, Chakraborty et al. 2018) or funding prospects to support their circular economy plans. Moreover, circular economy may need changes in established business models, such as moving from a linear "take-make-dispose" model to a circular model based on resource recovery and recycling (Bonciu 2014), which can pose challenges in terms of revenue streams, pricing, and profitability.

Overcoming these challenges may involve a multi-faceted tactic, including raising awareness, building capability, advocating for supportive policies, nurturing partnerships (Batista, Gong et al. 2019), creating market demand, and supplying financial incentives to persuade SMEs to adopt circular economy methods.

Literature review

Throughout this proposal document, a literature review has been carried out and references have been made to relevant publications in each section. A well-structured and wide-ranging literature review in a research proposal is vital for establishing the significance of the proposed research, offering the essential background and context, identifying the research gap, assessing current research, and justifying the research project and methodology. It helps to guarantee that the proposed research is grounded in existing knowledge and adds to the advancement of the topic (Efron, Ravid 2019).

Manufacturing journals

The subject of Circular Economy is a highly popular one across scientific journals, from manufacturing to economic publications. The process of narrowing down potentially relevant articles may be filtered down as per this example from Bjornbet, Skaar et al in 2021:

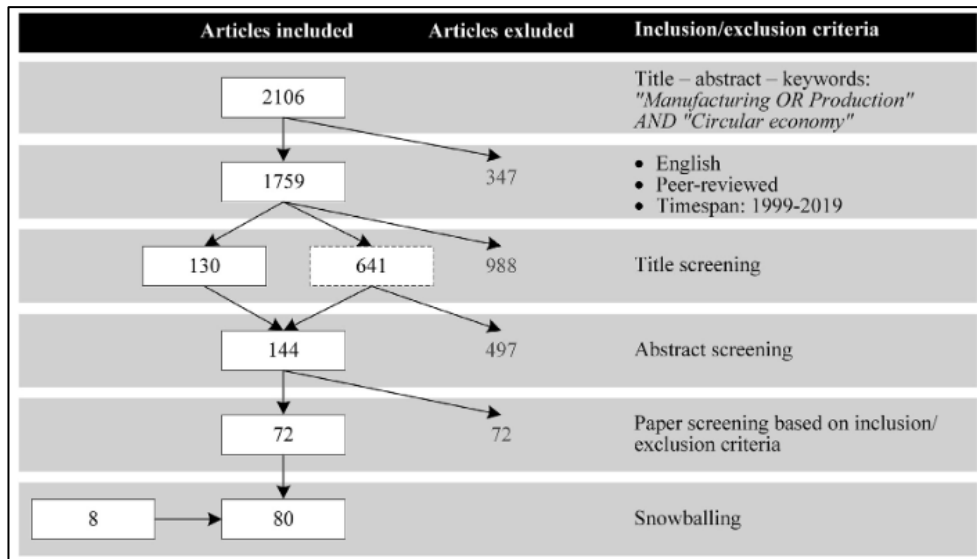


Figure 4 - Schematic overview of the sorting and exclusion procedure used to assess the relevance of the literature obtained in the data collection step. (Bjørnbet, Skaar et al. 2021)

Legislation

It is important to note that circular economy regulation and guidelines can vary broadly dependent on the location and circumstances in which they are applied. It is advised to refer to local laws and rules for accurate and up-to-date information on circular economy-related legislation (Fitch-Roy, Benson et al. 2021).

Some examples of legislation that may be relevant to promoting circular economy practices may be:

- Extended Producer Responsibility (EPR) laws
- Waste management and recycling regulations.
- Green procurement policies (EU Environment 2014)
- Eco-design and product standards
- Incentives and subsidies such as investing in recycling infrastructure, supporting repair and refurbishment activities, or using recycled materials in manufacturing processes (Singh, Chakraborty et al. 2018).
- Bans or restrictions on certain products or materials, such as single-use plastics, certain hazardous chemicals, or non-recyclable materials in packaging.

In the UK, The Circular Economy Package (CEP) published by the government (GOV.UK 2020) focuses mainly on for the reduction of waste, batteries and packaging. The country is behind other European nations such as The Netherlands, France, Italy, Germany,

Luxembourg, Belgium, Portugal, and Spain when it comes to CE initiatives. (Construc a 2020)

The European Union itself has recently implemented regulations to ‘name and shame’ companies guilty of green washing (EU 2023).

Funded Projects and Collaborations



Figure 5 - Example of collaborations: Cresting is an Academic Supporter of the UK Plastics Pact

Another facet of CE being at the forefront of the narrative in policies or corporate social responsibility reports (Friant 2021) means that there are projects funded by various organisations which are led by academics and comprised of people from various geographies and fields of expertise resulting in a rich inter-discipline contribution to the CE field.

One of the outputs of such a project - Cresting (Deutz 2019b) is an interactive timeline of circular economy thinking which publishes more than seventy circularity ideas from across the globe. Based on in-depth researching conducted by the CRESTING project and was published in the Journal of Resources Conservation & Recycling (Calisto Friant, Vermeulen et al. 2020).

The purpose of this interactive timeline is to assist analysts and professionals to understand and evaluate the concept of CE better and from another potential point of view. It can achieve this by presenting the historic beginnings in a global context and the current period dubbed – The Validity Challenge Period- with its plethora of theoretical concepts. The aim of the resources and of the project itself is to champion cross-disciplinary approaches to address the socio-ecological challenges of the 21st century. (Deutz 2019a)

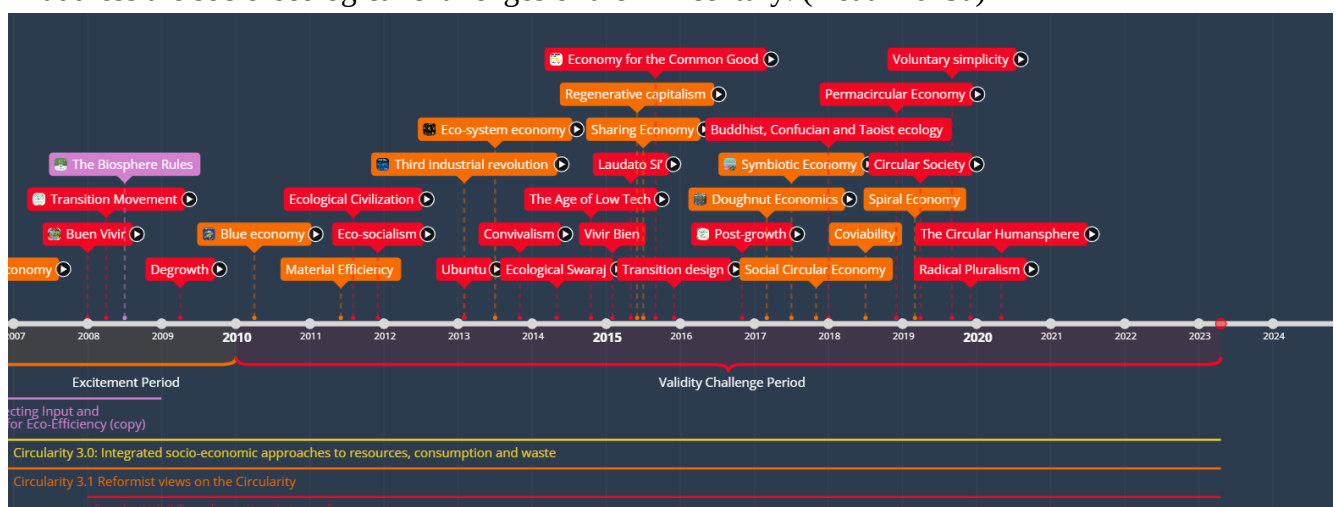


Figure 6 - circularity timeline (Deutz 2019a)

Methods

“Addressing theory can begin at the beginning of a research project – engaging with theory and evaluating a hypothesis or theory can be arrived at after the research has been carried out” (Dearing 2022)

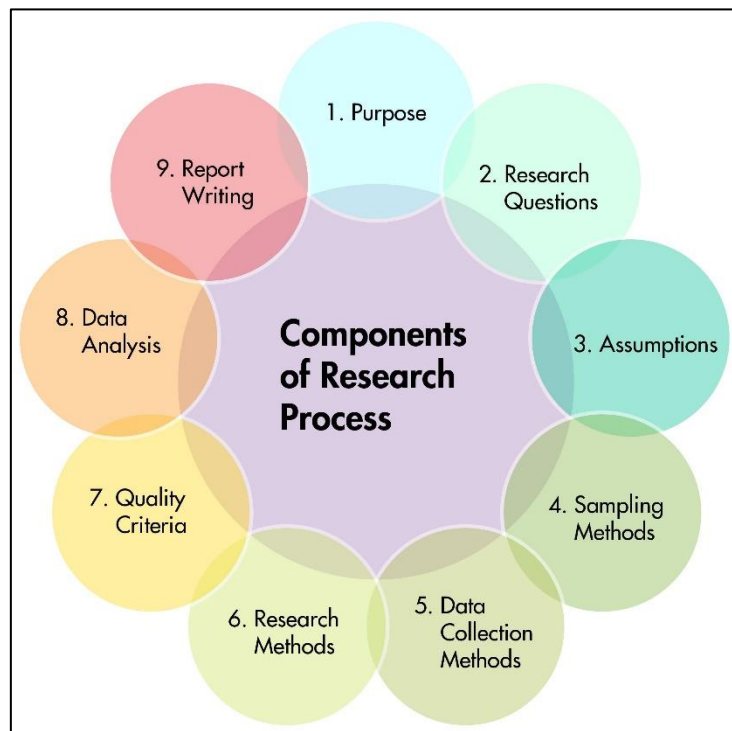


Figure 7 Components of Research Process (Dearing 2022)

Qualitative and quantitative research methods are two distinct approaches used in research to collect, analyse, and interpret data in different ways (Creswell 2014).

Key Differences:

1. **Data Collection:** Qualitative research gathers non-numerical data, whereas quantitative research collects numerical data.
2. **Data Analysis:** Qualitative research uses methods such as thematic analysis, content analysis, or grounded theory for data analysis, while quantitative research uses statistical techniques for data analysis.
3. **Context vs. Generalization:** Qualitative research provides deep and contextualized depictions of the research phenomenon, whilst quantitative research focuses on generalizing about a given subject of research.
4. **Subjectivity vs. Objectivity:** Qualitative research acknowledges the subjective angles of participants and investigators, while quantitative research aims for objectivity in statistical analysis (Dearing 2022).

Both qualitative and quantitative research methods have their strengths and limitations, and the choice between them depends on the research question, research design, and the specific goals of the study. They can also be combined in mixed methods research to provide a more comprehensive understanding of a research topic (Creswell 2014)(Dearing 2022).

Quantitative research methods- Stock and inventory management

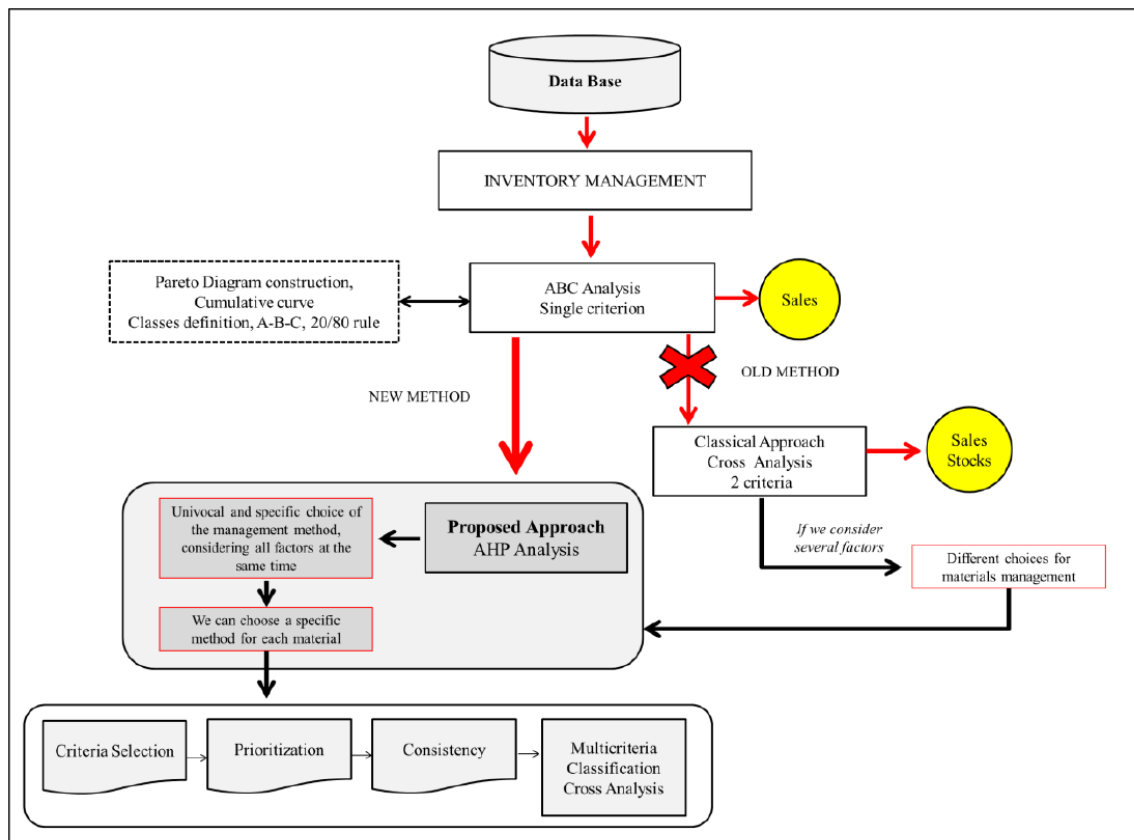


Figure 8 - Inventory Management Framework with the two methods (De Felice, Falcone et al. 2014)

The first step to implementing the CE methodology in the business is the short-term project of taking inventory of the company's stock and managing it by identifying and categorising the inventory for the purpose of using all the suitable legacy materials and assemblies as opposed to purchasing new- CO2 generating - raw materials.

De Felice posited that inventory is one of the most important assets of a manufacturing business. How the business manages its stock gives stakeholders, clients, employees, and the public understanding of the company's position and economic health.(De Felice, Falcone et al. 2014)

A combination of industrial inventory techniques such as ABC analysis, which is categorising items from most important -A to least important – C, and Analytic Network Process (ANP) must be used (De Felice, Falcone et al. 2014), considering the dissimilar nature of the stock, from raw materials – steel plates, bars, profiles to proprietary cots (commercial of the shelf) equipment such as gearboxes, motors, control panels, hook blocks, ropes, and chains.

Unlike the medium- and long-term projects, this is 100% internal process. The base assumptions, timelines and budgets are laid out in table 1.

Activity	Equipment	Human resource	Timeframe	Cost
Stock identification and marshalling	3D scanner	-Storeman -Engineer	3 months	£4,500.00 (cost of scanner)
Stock preparation and cleaning	Laser cleaning machine	-Storeman -Warehouse operative	1 month (within the first activity timeframe)	£15,000.00 (cost of laser cleaning machine) – cost to be split with painting department for surface preparation prior to coating
Database creation on MRP system and stock reconciliation with SAGE system	-	- Engineer - Purchasing operative	3 months (starting 2 months after the first activity begins)	
Stores restructuring based on inventory management hypothesis	-	-Storeman -Engineer	1 month	
Totals			6 months	£ £12,000.00

Figure 9 - Table 1 - Plan for inventory digitalisation

The deliverable at the end of the inventory project will contain data pertaining criteria as ordering cost, criticality of part, commonality, obsolescence, reparability, scarcity, durability, demand (De Felice, Falcone et al. 2014).

To achieve the results, the operatives will make use of Industry 4.0 methods like 3D scanning and the IoT (internet of Things) (Matt, Modrák et al. 2020)

Qualitative research methods and mixed methods triangulation



Figure 10 - Qualitative research methods (Dearing 2022)

As mentioned in the background section of the proposal and, the complexity implementing CE methods in the supply-chain requires commitment from all the tiers within it (Batista, Gong et al. 2019).

To achieve the medium- and long-term goals of using CE models, the quantitative methods will be mixed with qualitative research such as case studies; interviews; focus groups; ethnography (Creswell 2014).

During the initial stage of the project, all the supply chain participants will be approached for a Circular Economy feasibility Survey. Each respondent will be introduced to the concept of circular economy and will be asked to fill in a questionnaire containing questions regarding their companies' current attitude and commitment for achieving CE readiness; how social pressure and perceived behavioural control influences their inclination towards adopting CE practices; and what is the role of environmental commitment and green economic incentives in swaying their business towards CE readiness (Singh, Chakraborty et al. 2018).

The data from these questionnaires will be compiled and used in a case study on each of the supply chain companies for the purpose of evaluating the respective business in terms of the CE readiness and potential contribution to the long-term project of the SME.

A different questionnaire will be sent to the SME's clients with the dual purpose of understanding where does Circular Economy and supply-chain sustainability rank in their corporate socio-economic responsibility report statements and to glean through abductive research if the client would respond favourably to the SME's culture change towards circular economy.

Results

For the short-term project of inventory management, the expected result is a comprehensive and interactive database which will categorise varied materials by a mixture of criteria as enumerated in the methods section.

For the medium-term project, the expectation is company-wide dissemination and implementation of CE policies, with buy-in from all personnel, evidenced in day-to-day behaviours and evaluated periodically through signed and recorded questionnaires. (Murray, Skene et al. 2017).

For the long-term project, the consideration is the establishment of a CE ready supply-chain.

Evaluation

The importance of implementing a CE model in the manufacturing SME goes beyond the company itself, beyond the supply chain and even beyond any market position improvements garnered by said implementation. It affects the future of the industry – not running out of raw materials, and most importantly, it can have a positive impact on the environment.

The success of the study will be limited by the uptake of the decision makers in the company, and the transparency of the questionnaire responses along with future financial pressures on the entire supply chain. (Ünal, Urbinati et al. 2019)

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