The relationship between resource scarcity and the implementation of circular supply chain practices.

Author: Tijn Kooi
University of Twente
P.O. Box 217, 7500AE Enschede
The Netherlands

ABSTRACT,
Resource scarcity is identified as a factor contributing to disruptions in the supply chain. Multiple different strategies to manage negative effects have been proposed over the years. An emerging approach is the concept of the circular supply chain, which can provide profitable results. Both topics have been researched individually, and a concrete relationship has not yet been identified. This thesis provides new information about how resource scarcity leads to circular supply chain implementation alongside the barriers that hinder changes. Through interviews with supply chain professionals, data was collected. The analysis of the results showed that resource scarcity does not have an impact on the implementation of circular supply chains. The losses and risks created by scarcity are inadequate to demand instant change. Traditional mitigation strategies, such as building safety stock and finding new suppliers, currently prevail in handling scarcity events, although they can be ineffective in the long term. Due to the lack of urgency, companies opt for a gradual transition to implement circular elements, which is often pushed by new directives and laws. The findings highlight a gap between awareness and action, suggesting that resource scarcity alone is insufficient to enact change within the supply chain.

Graduation Committee members:
1st supervisor: Dr.ir Niels J. Pulles
2nd supervisor: Dr. Vincent F. Delke

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1. INTRODUCTION

Scarcity within supply chains can lead to large disruptions within industries. During the COVID-19 pandemic, a shortage of chips arose, impacting numerous industries and causing a rise in the prices of many goods. The EU acted by implementing the Chips Act to ensure less dependency on other regions. Yet, lead times for solutions caused the crisis to continue for multiple years (European Commission, 2022). Scarce resources have always been sought after as they are often necessary for production and provide a competitive edge. Resource scarcity can be predicted through the factors of expected resource scarcity and scarcity uncertainty (Wiedmer & Whipple, 2022). To be able to conduct business where scarcity is present, managers must be able to understand how to handle scarcity and predict their implications. With natural resources depleting, companies are looking to optimise supply chains. A strategy that is eagerly pursued is circularity (Wang & Azam, 2023). The circular supply chain incorporates the idea of the circular economy framework in a supply chain (Montag, 2022). The framework is based on the idea of waste management and the 3Rs: reuse, reduce, and recycle (Mohammed et al., 2021). Being able to efficiently use scarce resources will reduce the risk of disruptions. Therefore, to implement a circular supply chain is deemed a good investment. Studies have shown that optimal benefits can be gained when a multi-level closed supply chain is implemented (Tseng et al., 2019). However, not all organisations are looking to change their operational systems.

Research has been conducted on how scarcity can be managed in multiple ways and its effect, ranging from individual to social impact (Cannon et al., 2018). Furthermore, resource scarcity has been examined from the point of view of consumers (Barton et al., 2022). Resource scarcity has an impact on both businesses and consumers, as the lack of necessary materials can impact daily processes. There have been studies on how circular economy can mitigate the supply of critical resources (Gaustad et al., 2017). Natural resource scarcity has also been examined through a closed-loop system with the view focused on resources (Bell et al., 2013). Scarcity has been examined in many different ways for many different stakeholders. Within the field of circularity, there have been studies discussing closed-loop systems and mitigation, but there is a lack of how it influences the evolution. Supply chains do not change abruptly and are often a strategic choice requiring large investments and reorganisation. With more information on the consequences of natural resource scarcity, it is important for companies to act to avoid unnecessary risk and envision a long-term future. Circularity within supply chains has been researched and deemed very effective in reducing risk, but can also cause supplier switches or new problems if done inefficiently (Zeng et al., 2016). Whilst some companies have chosen to implement circular supply chains as a means to become more sustainable, it is unclear in what sense these changes are caused by scarcity. Therefore, in this thesis, it will be researched to see how scarcity and circular supply chains are connected.

Prior research into circular supply chains and their effectiveness and obstacles has been done. Circular supply chains can allow operations to run more efficiently and reuse, recycle, and gain more control over resources, increasing operational agility. These methods are a solution for problems caused by resource scarcity, which can cause a supply risk and failure to produce the required demand. The effects of scarcity have been well researched, however, the effect of scarcity on changing procedures, such as circularity, has not been explored enough. To explore the connection between resource scarcity and the implementation of circular supply chains. The following research question will be investigated in this thesis.

How does resource scarcity affect the implementation of circular supply chains?

To gather sufficient data, 9 interviews have been conducted with experts in the field of supply chain at multiple companies active in different countries. All of the interviewees have experience within their respective roles, which makes them suitable candidates. To effectively seek out how resource scarcity affects circular supply chain implementation, one interviewee is functioning within a complete circular supply chain, which allowed a more thorough exploration of differences between circular and non-circular responses to resource scarcity.

The main purpose of this thesis was to show how resource scarcity affected organisations to adopt circular supply chain practices. Furthermore, to identify the factors that cause them to be unwilling to change. This filled the gap in the literature between scarcity and circular supply chains. Based on the results, interesting conclusions can be drawn. Firstly, resource scarcity creates more awareness of circularity but does not cause direct implementation. Secondly, the need for large investments and the lack of support from shareholders create a lack of urgency to implement circular practices. Governmental policies do require changes towards circularity, but with long due dates, the lack of urgency persists. Lastly, resource scarcity causes a high supply risk, which is currently a risk that supply chain managers accept as they opt to find new suppliers and use high safety stocks to alleviate risk instead of investing in circular supply chains. The research showed that whenever possible, the change towards circularity is pursued, and a gradual change is preferred as resource scarcity does not provide a sufficient impact to warrant a supply chain overhaul.

2. LITERATURE ANALYSIS

2.1 Scarcity

Scarcity is a lack of something, ranging from individuals and talent to commodities and natural resources. Resource scarcity can be defined as a lack of abundance or insufficient supply of a necessary commodity (Cunha et al., 2013). In this thesis, the focus will be on resource scarcity. There are different versions of resource scarcity: demand induced, supply induced, and structural scarcity (Bingham Jr, 2001). Demand induced scarcity relates to an increased need for consumption, supply induced scarcity is when environmental degradation causes a lack of available resources. Lastly, structural scarcity means that certain regions have less access to certain raw materials than others. Supply chain managers often seek to control scarce resources as it provides a competitive edge. When scarce resources become essential in production, the risk of having no supply is greater than its advantage it provides (Carr, 2004). When the world was introduced to microchips and the internet, it was a scarce resource that provided a competitive advantage if utilised properly. As development continued, its importance increased and became a necessary commodity for businesses. This shows that resource scarcity has a direct impact on business practices, hence an environment that is lacking adequate resources for a prolonged time is subject to structural changes (Koberg, 1987). This shows the importance for supply chain managers to understand scarcity and how to handle these situations within their organisations.

Scarcity is incredibly varied, ranging from resource to talent induced. For supply chain managers to be able to grasp the complexity of what scarcity can cause within a supply chain, different metrics have been proposed. They can analyse and

judge potential situations by mapping the expected severity, duration, and timing to determine the expected resource scarcity (ERS) and Scarcity Uncertainty (Wiedmer & Whipple, 2022). In times of scarcity, managers can use structured frameworks to guide effective decision-making. A study to determine whether scarcity is human induced concluded that 2 trends emerge. Society limits its appropriation, but competition increases, causing resources to be diminished at an even faster rate (Osés-Eraso et al., 2008). These conclusions lead to the belief that scarcity is different within each enterprise and that when a scarcity event occurs the reaction of each firm is different. A study (Daft et al., 1987) states that everyone reacts differently to the consequences induced by scarcity. A framework for individual reaction to scarcity has been created by (Cannon et al., 2018) which proposes a reaction to resource scarcity through two primary psychological pathways: attempting to reduce the scarcity itself or seeking to restore a sense of personal control. Managers like to understand the situation at hand, however, scarcity is an issue that can best be tackled through partnerships. A strong connection with a supplier to solve the problem is beneficial. Handling the situation together can strengthen the partnership.

The response of individual people to scarcity is well documented, and allowed more focus to explore how organisations react to the impact of scarcity. With natural resources becoming more scarce in the world, the previous mitigation strategies, such as changing suppliers or aiming to discover new resource-rich areas, have declined in effectiveness (Bell et al., 2012). Because of these developments, successful management of scarce resources is vital for the continuation of production processes (Wang & Azam, 2023). Because of this, the research into handling scarcity through resource efficient methods has increased. A common method that has been proposed in closed supply chain loops. Closed-loop supply chains cause organisations to be ready for sudden scarcity. Furthermore, it can enhance resource productivity, recognise and respond to scarcity, whilst letting them build a competitive advantage by making core products without needing to return to the marketplace (Bell et al., 2013). This research however looked through a singular closed loop, which in more complex supply chains would be insufficient. For supply chains where scarcity impacts more than one element, a multi-loop supply chains provide the means to handle scarce events in the same way a single closed loop can. However, for large supply chains, it also means that there is a large need for investments to change (Tseng et al., 2019). A scarcity in the beginning can exponentially grow to become a larger problem, and to only change elements within the supply chain is not enough to alleviate risk. Especially firms that have a long supply chain would face detrimental changes as suppliers further downstream the supply chain impact the prices more severely (Gaustad et al., 2017). Closed-loop supply chains can allow products that reach the end-of-life to be taken back and be produced into a brand new product without needing new raw materials, and thus being less impacted by scarcity (Wang & Azam, 2023). However, stakeholder cooperation is of vital importance for investments such as multi-loop supply chains. Financial challenges are common, but there are more challenges in implementing looping action. In a case study of 58 challenges, (Williams, 2019) found that next to finances, a lack of data, a lack of common standards and institutional capabilities were the main barriers. Another strategy that has become more common is to engage in scarcity, to drive innovation in order to make better use of resources (Cunha et al., 2013). Engaging in scarcity allows for an analysis of where it is most impactful. In some cases, a scarce event can be incredibly rare and an overhaul of the supply chain can be rash even when it has long-term competitive advantages. Within case studies, results supporting their respective frameworks have been found, but they were conducted in targeted business areas instead of using a larger sample size. A larger sample of businesses that looks into how scarcity influences willingness to change is currently missing. A lack of natural resources has created a necessity for optimisation within supply chains and firms are starting to adopt strategies such as circularity to achieve these targets (Wang & Azam, 2023).

2.2 Circular supply chain management

Circularity has its foundation in the 3R strategy: reuse, reduce, and recycle (Del Giudice et al., 2020). A circular supply chain is the idea of installing a closed system that reduces the primary resources used through waste minimisation. This is done instead of the linear supply chain of take-make-dispose. A definition derived from a literature analysis by (Farooque et al., 2019) is "Circular supply chain management is the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems. It systematically restores technical materials and regenerates biological materials toward a zero-waste vision through system-wide innovation in business models and supply chain functions from product/service design to end-of-life and waste management, involving all stakeholders in a product/service lifecycle including parts/product manufacturers, service providers, consumers, and users." The definition can be simplified in the following way: Circular supply chain management is about reusing materials and reducing waste by designing products to last, be reused, or recycled, involving everyone that is part of the process. If this is all integrated correctly, it creates long-term economic benefits and sustainable development whilst reducing supply risk (Morseletto, 2020). Furthermore, it creates supply chain resiliency, resource efficiency, competitiveness, and cost savings (Lahane et al., 2020). Scarcity is a force of disruption in the supply chain and circularity offers a buffer that causes the effect to be less impactful on the operations.

To switch to circular supply chains, a large investment is required, but once it is implemented a circular supply chain allows for economical gains, more control over the supply chain, fewer threats of scarcity due to needing fewer resources for their operations (Zeng et al., 2016). The same study also stresses that efficient implementation is more difficult if the relationship with the supplier is strained. In a study of 125 articles about circular supply chain management, it was concluded that the main focus is on looping, optimisation, and regeneration (Lahane et al., 2020). From 2018 onwards, research into circular supply chains has grown intensively. This is due to stakeholders looking for solutions against unsustainable development, which has increased the social relevance of circular supply chains (Lahane et al., 2020). Social pressures are a driving force for the adoption of circular practices. The Paris agreement is an example of such a social pressure. To appease the stakeholders, managers change ways and switch to new methods instead of the take-make-dispose supply chain (Centobelli et al., 2021). The main driver for organisations is financial gain. All new methods need to have a financial benefit in the long term, preferably also having providing instant financial benefits. New methods, such as closing and slowing loops, are ways that companies can maintain profits while appeasing the public. Closing loops are based on the recirculation of materials, whilst slowing loops aim to prolong the end-of-life of products (Hazen et al., 2020). Implementation of such loops allows for more control over the resources once they enter the supply chain and causes less dependence on the stock of raw materials. Therefore, looped supply chains are a strong measure in handling scarcity. A model proposed by (Lieder & Rashid, 2016) delves more into the effect

that circular economy has on scarcity. It proposes that through circular economy implementation, resource scarcity creates less resource dependency and limits price volatility. Furthermore, it leads to lower speeds in resource depletion and waste generation. Circularity of resources and materials increases control over operations and mitigates risks from external factors influencing supply (Lieder & Rashid, 2016). Circular supply chains also have struggles that can arise. The main challenges found during a multiple case study were: loss of users' control over products, return flows uncertainty, transportation and infrastructure, availability of suitable supply chain partners, coordination and information sharing, and product traceability (Bressanelli et al., 2019). By having potential obstacles mapped out, organisations looking to evolve their supply chain can do a risk assessment beforehand. Using the risk assessment, they can predict possible implications for the chain of operations. It is imperative to foresee potential pitfalls as the implementation of circular economy practices within a supply chain can otherwise cause more harm (Zeng et al., 2016). Disruptions and overhauls are never without any risk; therefore, it is understandable why organisations with a functioning supply chain are not eager to overhaul their way of conducting business.

Scarcity can lead to disruptions of a supply chain as well and remains a risk. With natural resource scarcity increasing, these risks will continue to grow (Wang & Azam, 2023). Circular supply chains are a means that can decrease dependency on resources and are being researched and implemented at a faster rate. The current research is however focused on the effectiveness of circularity and the pitfalls of the implementation. It can be seen that effective factors against scarcity are the reduced supply risk and support from stakeholders. A further analysis of how scarcity affects the willingness to change supply chains is required to see how scarcity affects circular implementation, which will be done in this thesis. This will be done using the foundation set by all the previous research done on defining the topic and identifying the drivers and barriers.

2.3 Research framework

To effectively study the link between resource scarcity and the adoption of circular supply chain practices, a research framework is established *(figure 1)*. The expected relationships are derived from prior research. Scarcity impacts the supply, and therefore, supply risk increases. Circularity causes less need for new supply and more control over materials used. Because of these theories, supply risk is seen as a mediating factor. Circular supply chains are tools that help reduce supply chain risk, which in turn helps create a competitive advantage in businesses that deal with scarce materials (Govindan & Hasanagic, 2018). Based on prior research, the expectation is that stakeholder interest has a positive effect on adopting circular practices within the supply chain (Hussain et al., 2023). Resource scarcity impacts the availability of a material and thus increases the supply risk. A drop in the supply of a necessary raw material can cause downtime and affect the competitiveness of a company. Lastly, when dealing with resource scarcity, the structure of a firm and how it handles the situation can be pressured by stakeholders aiming to apply changes. Based on these conclusions, the following framework has been made.

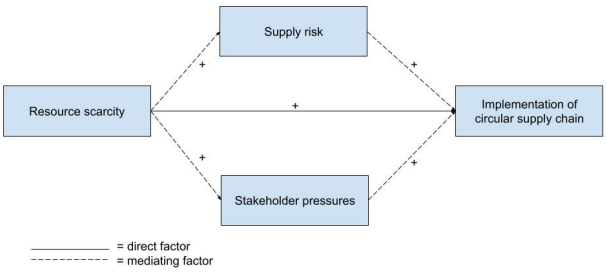

Figure 1: Research framework

3. METHODOLOGY

A qualitative study across multiple firms has been selected for this thesis. The aim of using this method was to provide understanding about how scarcity influences firms across different sectors to implement circular supply chains and the obstacles they face. A qualitative study was chosen as it allows for understanding certain experiences that individuals faced, which takes the context into account. Furthermore, it is better since the study will be conducted in multiple business areas. Buyers and suppliers were interviewed with pre-established questions, with room to pursue interesting points of discussion when they arose. Qualitative research is best in handling subjective matter and allows for flexibility (Babble, 2013). This thesis aimed to find out how resource scarcity influences the willingness of firms to adopt circular supply chain practices. Therefore, managers and other professionals in businesses that have or have had scarcity problems within their respective fields were sought out. Mainly, people with multiple years of experience in the supply chain. They could provide actual insights, share experiences of events they encountered, and comment on potential shifts in business values. The choice to focus on both buyers and suppliers was made to avoid bias in the results due to a lack of representation of one side. For the same reasons, multiple different companies were selected since focusing too narrowly on one sector could skew the results to that specific market. Depending on the reliance and severity of scarcity, different measures will have been taken thus a broader sample is necessary. It allowed for an analysis of different cases and provided an overview of common techniques to handle scarcity situations. The sample includes firms that have adopted circular supply chains, are in the middle of transitioning, or have opted to stay with their current process. These tiers show the effectiveness of circularity with respect to the effect of scarcity events as well as find patterns of how scarcity leads to circular supply chain implementation and the reasoning behind the made decisions. All firms participating have needed to experience some form of resource scarcity within their supply chain to provide relevant information. This is so that differences could be thoroughly analysed and a conclusion about the impact of scarcity could be drawn. The focus when analysing the interviews was on finding common indicators and factors that are caused by scarcity, and how this causes supply chains to apply circular approaches, or why other techniques are used. To find a sufficient answer, parts of the initial steps of the Eisenhardt method are used (Eisenhardt, 1989). A careful case selection with common antecedents was used to find patterns and reveal differences and similarities between organisations on the influence of scarcity in circular supply chain implementation. However, in contrast to the Eisenhardt method, only qualitative data was used instead of a variety of different sources.

3.1 Data collection

The data has been collected through interviews with professionals in the field of supply chain. These interviews had specific questions to help answer the proposed relationships between factors as shown in the framework *(figure 1)*. The interviews were around 15-20 minutes and were held through Microsoft Teams, apart from 1 which was able to be done in person. These interviews were recorded and transcribed if permitted, which was permitted for all interviews. This was done so that during the interview, the focus was solely on the conversation instead of simultaneously taking notes and missing important information. Before each interview, there was a window for small talk in which the research was explained to ensure everyone felt comfortable before starting, and any prior misconceptions could be resolved. For the interviews, the following question scheme *(table 1)* was used to gain sufficient information to answer the research question. If questions were already covered through an elaborate earlier answer, then it was skipped. This is in line with the interview guide approach proposed by (Tashakkori & Teddlie, 2010), meaning that the order and wording of some questions were altered depending on the participant. 1 interview was held with a researcher in the field of supply chain management within a circular economy, and since the person is not active within a company, a different interview scheme was used. The insights of the researcher provided a baseline and helped corroborate observable patterns that emerged from the other interviews. The interview scheme for the researcher can be seen in (*appendix 1)*.

Table 1: Interview scheme

Section	Question	Goal
Background	Could you please explain your role within the company?	Information about interviewee
	How long have you been working at the company?	Information about interviewee
	What industry are you most active in?	Information about company
Scarcity Experience	In what ways have you experienced resource scarcity? And can you provide examples?	Information about scarcity
	What were the effects of scarcity on your supply chain operations?	Impact of scarcity
Response to Scarcity	What measures were taken to avoid the impact of scarcity in the future?	Information about handling of scarcity
	How effective were these measures?	Information about handling of scarcity
Circular Supply Chain Exploration	Are you familiar with the concept of circularity?	Knowledge about circularity
	Have you ever considered to implement circularity to handle scarcity induced problems?	Relationship between scarcity and circular supply chain
	Why have/haven't you opted to switch towards circular supply chains?	Determine factors that contribute/withhold change
External Pressures	Have you noticed stakeholders pushing towards circular supply chain implementation?	Impact of stakeholders
	If so what are the main reasons for them pursuing circularity?	Stakeholder drivers
	In what ways do stakeholders react to the effects caused by scarcity?	Relationship stakeholders and scarcity
Supply Risk	What are moments where there was a high supply risk within your operations?	Supply risk moments
	To what extent does scarcity influence your supply risk?	Scarcity and supply risk
	Would supply risk be a reason to adopt circular supply chain practices?	Impact on supply risk
Outlook	Do you think circular supply chains will become standard in your industry in the next 5–10 years?	Explore long-term vision and expectations
Wrap-Up	Are there any further comments you would like to make?	Allow for more information to be given

3.2 Data Analysis

All interviews were recorded and automatically transcribed. As software is known to make some mistakes, the recording was listened to, and the transcript was corrected when errors were found. Each recording was listened to twice before finalizing the transcript. This method is in line with verbatim transcription, which is analyzed by (Halcomb & Davidson, 2006). It provides accurate and valid results on what is said. A common criticism is the lack of visual and social cues when only handling the transcript data. But as results were handled anonymously, there is no reason for interviewees to have lied to save face for the company. The assumption was made that truth would always be spoken. Therefore, the exact wording is of higher importance than social cues to be able to find relevant results. The transcripts were also shared with the interviewee if they wished, so that they could make it known if they had any problems following the transcription.

Using the transcript, the proposed connections were categorised into emerging patterns and differences. When analyzing the results, there was a heightened focus on answers that correspond with the columns of *table 3*. The interviewees were occasionally enthusiastic about topics outside of the scope, mainly capacity scarcity. Those answers were not cut off during the interview, as they provided more understanding about problems within the company. Answers that did not fit in the scope of the research were, however not considered in the results section except when they provided context for why certain decisions were taken. Common answers were categorised and highlighted to find patterns within the results from which the conclusions are derived. Based on those findings, conclusions were drawn that

correspond with the proposed relationships from the framework *(figure 1)*. Using that information conclusions were drawn to answer the research question.

4. RESULTS

9 interviews were held and transcribed. The industries in which the respective professionals were active, as well as the length of the interview, can be seen below *(table 2)*. The short answers of every participant regarding their scarcity events, the effect on their business, their response, the severity of supply risk it created, the pressure applied by stakeholders, and their consideration regarding circular supply chain implementation can be seen in *(table 3)*. Every interviewee has been assigned a code based on their respective industries and the countries they are active in. Each company has been placed within its industry to retain anonymity. The interviewees are all active within the supply chain with knowledge of sourcing and raw material processes. However, their field of expertise were in different areas, such as logistics, management, or sustainability, with RE-NL1 being an exception. RE-NL1 conducts research within the field of supply chain management within a circular economy and provided further clarifications of the overall trend. Of the 9 interviewees, 2 are active in Spain, 1 in Belgium, and 6 in the Netherlands.

Table 2: Overview of interviewees

Code	Role	Country	Industry	Duration
IGC-NL1	Supply chain manager	The Netherlands	Industrial goods and consumables	13:45 minutes
FMCG-BE1	Global supply chain manager	Belgium	FMCG (Fast Moving Consumer Goods)	27:35 minutes
RE-NL1	Researcher	The Netherlands	Expert in the field of supply chain management within a circular economy	18:37 minutes
FMCG-NL1	Sustainability & Transformation manager	The Netherlands	FMCG	21:06 minutes
P-ES1	Supply chain operations director	Spain	Paper	21:04 minutes
FMCG-NL2	Project lead ERP (Enterprise Resource Planning) + Supply chain	The Netherlands	FMCG	18:10 minutes
T-NL1	Business developer transitioning for industrial systems	The Netherlands	Transportation	16:23 minutes
EF-NL1	Seasoned supply management executive	The Netherlands	Electronics & energy + Furnishment retail	23:48 minutes
FMCG-ES1	Logistics Manager	Spain	FMCG	13:03 minutes

Table 3: Overview of interview results

Person	Scarcity events	Scarcity response	Scarcity effect	Supply risk	Stakeholder pressures	Circular practices adopted
IGC-NL1	Bad pepper harvest	Safety stock	Unaligned with partners causing disruption and increased prices	High	Medium	Medium-low

FMCG-BE1	Peanuts supplier problems	Safety stock, search for new supplier	Unable to complete orders, increased prices and risk of being delisted	Medium	Medium	Low
RE-NL1	Trend of increasing lack of raw materials	Reuse-reduce-recycle. Focus on prolonging product life	Downtime. Large companies struggle with identifying factors before it is too late	High	Low	High for start-ups Low for large companies
FMCG-NL1	Cacao and grains shortages	Spot market buying	Cost, Quality and availability issues	High	Medium	Medium-low
P-ES1	No scarcity events	/	/	Low	High	Circular supply chain in use
FMCG-NL2	Packaging and organic raw materials	Change recipe, standardise packaging, increase safety stocks	Delisted, availability issues	High	Low	Medium-low
T-NL1	Upcoming scarcity of high quality steel	Attempt to secure contracts with supplier over competitors	Need steel to comply with regulations. Otherwise an overhaul of production is necessary	High	High	Low
EF-NL1	Lack of resources for mass production	Outsource, look at alternative suppliers. Close decoupling points	Product scrapped or specifications changed	Medium	Medium	Medium-high
FMCG-ES1	Far away production causing lack of acquisition	Build up stock, work with larger lead time	Increased prices	Low	Low	Low

4.1 Current methods to handle resource scarcity

The interviews revealed that the most common techniques used in handling resource scarcity induced problems are to use and, if possible, expand **safety stock** and **find new suppliers** to ensure the supply chain becomes more **agile and resilient**. P-ES1, which operates in a completely circular supply chain, had no events of scarcity in the 2,5 years that he has been active within the company. They have partnerships with companies using wood materials to gain access to natural fibers alongside wastepaper, which has a steady supply. 5 people mentioned that their initial response was to use their **safety stock** and rapidly assess how to stretch their resources to comply with orders from customers and seek out alternatives if possible. IGC-NL1 mentioned that errors with packaging do get recovered and reintroduced. This lead time is too large to lower **safety stocks** and continue to provide quick service to customers. If the scarcity remains for 10 days, the consequence is that not all orders can be delivered in time. FMCG-BE1, FMCG-NL1, FMCG-NL2, and EF-NL1 focus on finding a **new supplier** if vital resources become unavailable. FMCG-NL1 highlighted the undesirability of such situations as the costs increase, and a **new supplier** is an unknown in terms of quality and reliability. For FMCG-BE1, who has a supplier in South Africa, a sudden scarcity of peanuts, which were not available elsewhere in the country, meant accepting a lower production output or sourcing from markets with higher prices. Because of such situations, EF-NL1 stressed the importance of **agility** within a supply chain to be able to handle scarcity situations. Since scarcity events are often sudden mishaps, such as a bad harvest from a sole supplier or a fire that caused destruction, the winners in such a situation are those that can change direction quickly and have a lower dependence. FMCG-NL1, P-ES1, and EF-NL1 also mention that the importance of **resiliency** has come to light for companies operating in multiple countries following the disruption caused by COVID-19 and current political uncertainty. This showed that **resilient supply chains** are important in times of scarcity. Based on the results, the switch to **resilient supply chains** is done through increased **safety stocks** and the option to contact **multiple suppliers**, which, in times of scarcity, increases costs. The increased costs are a better alternative than an investment in circularity, which renders elements of the current supply chain process obsolete. 7 interviewees mentioned their desire to apply circular practices, but introduce them step by step, as it will be required in the future. An instant implementation would harm operational efficiency and profits. RE-NL1 corroborates this with his research, in which he identified start-ups embracing circular elements but large corporations struggling to adopt circularity fast enough to change effectively. Large corporations have their main priority on profits within existing legislation and seek out minor projects to appease societal views.

4.2 High supply risk

The interviews showed a pattern of resource scarcity, causing a **high supply risk,** which causes an **inability to meet demands,** which leads to a **loss of income** and **friction with business partners.** Scarcity of natural resources led to a **high supply risk** according to 5 professionals, 2 identified a medium risk, and 2 said there was a **low risk**. P-ES1, working in a circular

environment, had no scarcity events in the 2.5 years he has been active within the company. FMCG-ES1 could not see the extent of **supply risk** as the **demand exceeded their operational capacity**. The **high supply risk** caused by scarcity events harmed the business of IGC-NL1, RE-NL1, FMCG-NL1, FMCG-NL2, and T-NL1. The lack of supply causes **friction between buyers and suppliers** as the service cannot be provided as intended. In the case of IGC-NL1, there is complete dependence on the supplier, and there are no back-up suppliers in place to alleviate risk. Without the resources from their main supplier, it becomes **impossible to produce the required demand,** and therefore fail to supply their promised services to customers. In the case of FMCG-NL2, a long scarcity of pouches meant they had to delist the product until production became possible again, resulting in a **high loss** of potential turnover and a **worsened relationship with customers**. Scarcity increases **supply risk**, which can lead to an inability to provide services, a **negative impact on business relationships**, **and higher costs**. To avoid problems, replacement suppliers are sought out or spot market buying is enforced, according to FMCG-NL1, although this does come with **increased costs** and potential quality issues. The risks are further mitigated by producing less for a certain time and making use of safety stock. If the scarcity event, and thus the **supply risk,** persists for a prolonged period, this leads to a **potential fallout with either buyer or supplier**, a need to discontinue a product line, or new specifications to alter the product and bypass the shortage. Another option is to wait until the situation returns to the normal standard and accept the **loss of revenue** alongside other harmful impacts. RE-NL1 also found in his research that due to there being many tiers within the supply chain, the effect of a scarce material can sometimes be attributed to other factors. A misidentification of the problem unknowingly prolongs the harmful effects. This highlights the importance of effectively dealing with resource scarcity to lower the **supply risk**.

4.3 Stakeholder pressures

The interviews show that the **pressure applied by stakeholders** to deal with resource scarcity is different per representative groups, the ask for **implementing circular practices is pushed by governmental policies,** whilst **shareholders are content with the current strategies** used to handle scarcity events. Scarcity leading to losses creates an impact, but **not enough for shareholders to demand circularity**. However, **governmental interference** to counter climate change and pollution does require companies to adapt. RE-NL1 sees an overall trend that **shareholders** hold the most power to decide how a company operates and are focused solely on profits. The **lack of pressure** can be found in the business of FMCG-ES1 and FMCG-NL2, who, respectively, are **unaware of any pressure** or do not see any urgency that influences the business. On the other hand, **laws and directives create pressure** to pursue a sustainable path. P-ES1 operates in the paper industry and has to manage all their packaging according to the **PPWR** (European Parliament, 2024). This regulation, which goes into effect in 2026, is meant to decrease harmful packages polluting the environment. The focus on **implementing circularity** for IGC-NL1, FMCG-BE1, FMCG-NL1, and FMCG-NL2 is therefore on recycling and reusing their packaging and seeking out suppliers which are following the directive, which P-ES1 already does. The PPWR has a compliance term of 15 years and is mandatory for the EU market. **Regulations** are the only **pressure** able to enact real change, T-NL1 must decrease their emissions by 2030 and therefore must acquire steel made more sustainably. Without this **pressure,** no change in their operational behavior would be made. Other factors that have a minor contribution are the 'war on talent' according to FMCG-BE1 and EF-NL1, which entails that a company must be seen as desirable for employees to work at. FMCG-NL1 further mentioned that intrinsic motivation from a family-owned company is important as it also bypasses **shareholder influence**, as there is no presence on the stock market. After **governmental policies**, the main power lies with the **shareholder,** whose interest is in profiting from their investments, and without any **pressure,** companies will not alter operations. Scarcity causes **governments** to act, but it does not disturb **shareholders** looking for quick revenue.

4.4 Low urgency in adopting circular practices

The evidence collected during the interviews showed that there is a **low urgency** in adopting circular supply chain elements to deal with resource scarcity, with most companies opting to choose for a **step-by-step transition** with **small projects** that do not disrupt the entire supply chain. There are **no plans** for a complete change to circular practices, rather, only **small efforts** are made to switch parts of the supply chain to incorporate circularity. An entire closed-loop system is only used by P-ES1. The interviewees are active within large corporations that have a relatively standardised supply chain and thus have a resistance towards change. In the event of scarcity, they accept that costs could increase for a short time. However, **only 22% do not seek out any circular opportunities** when handling natural resources, which shows awareness and interest but a **lack of priority**. FMCG-ES1 mentioned that due to unforeseen growth, the main problem is scarcity of capacity, and all their focus is on optimizing the supply chain to meet the demand. T-NL1 has a monopoly and only seeks out options if they are required by laws and regulations. With a lack of competition, there is **no need to change processes**. FMCG-NL2 said, "We are really looking at the low hanging fruit first, and then, of course, the big churn." EF-NL1, who worked for a frontrunner within the furniture industry when it comes to circularity said, "the knife should cut on two ends." Therefore, large enterprises choose to adopt circularity using a **step-by-step approach**. RE-NL1 mentioned that most new entrants within the market space adopt circular practices from the start. It is a desirable feature from a societal point of view, however, large corporations lack the agility to invest in an overhaul without making large initial losses. FMCG-BE1 mentioned that when presented with a choice, they always **choose the sustainable option if costs are equal, but profit remains the most important**. The efforts that are made are related to recycling packaging, ensuring that the plastics used can be recycled, and an increased urgency to find suppliers that use recycled goods. FMCG-BE1 and FMCG-NL1 also mentioned projects that look into using waste from processes to help power and source other products, which can be seen as engaging with scarcity to drive innovation. With condiments however, this sometimes fails due to food safety concerns, but advancements are made and **opportunities are sought out**. The circular practices that do get examined are driven by the fact that reusing materials is beneficial for costs and allows for a more resilient supply chain, which helps in times of scarcity.

5. DISCUSSION

The goal of this thesis was to explore the effect resource scarcity has on the implementation of circular supply chain practices. Prior research has shown that installing closed-loop systems within a supply chain enhances control over resources. Thus, in times of scarcity, the risk is reduced as there is less dependence on new resources entering the supply chain. This has shown to be able to provide a competitive advantage, but a shift towards larger-scale implementation is lacking. Previous risk mitigation techniques have become less effective as scarcity events increase and competition increases. The research looked at scarcity and

circular supply chain practices as individual aspects. With this research, the connection between resource scarcity and the implementation of circularity in the supply chain can be better understood. There has been research that looked at the effectiveness, benefits, and obstacles concerning circular supply chains. Resource scarcity, too, has been extensively researched to find out what consequences arise from sudden scarcity and strategies that can be applied to handle the situation. With the findings of these 2 topics overlapping on multiple occasions, this research was established to examine the relationship between resource scarcity and circular supply chain implementation. Based on the results acquired resource scarcity has no direct affect on circular supply chain implementation.

5.1 Discussion of findings

The results do not show a positive relationship between resource scarcity and the implementation of circular supply chain practices, the barriers, mainly high investments and lack of agility, are dominant compared to the potential benefits of a lower supply risk, less dependence on raw materials, and lower operational costs. The theorised framework (*chapter 2.3)* based on the findings of prior research expected resource scarcity to have a positive effect on circular supply chain implementation. This relationship would be mediated by stakeholder pressure and supply risk.

Firstly, resource scarcity does not have a direct impact on the implementation of circular supply chain practices. This is because occasional resource scarcity is seen as an unavoidable problem, contradicting that "abundance is inevitable, whereas scarcity is manufactured" (Siderius & Zink, 2023). Strategies to mitigate risks and lower impact are chosen to handle scarcity events, as changing the operations provides a higher economic risk. Even though (Bell et al., 2012) found that the pursued strategies of searching for new suppliers have become more difficult. When scarcities occur for a prolonged period, the operations are affected which creates a loss in profit. Large companies are therefore keen to implement circular elements to gain more control over their operations, but the cost of innovation is too high in the short term. The financial risk of not complying with orders for a short period is lower than changing the supply chain. Smaller businesses and start-ups that have the flexibility to change their operations do seek out circularity. The main obstacle is the lack of agility in companies that mass produce, as it would render too many assets obsolete. The majority explore the circular aspect when introducing new products and analysing supply chain efficiency, yet the investments needed rarely outweigh the losses made due to scarcity. The current strategies of building safety stock and finding back-up suppliers have to worsen for scarcity to have a direct impact on the implementation of circular practices.

Secondly, resource scarcity has a positive influence on stakeholder pressure from governments, leading to a greater desire to implement circularity within supply chains. On the other hand, there is no impact on shareholders, which results in a negative effect on circularity efforts, as they appear content with the current situation. The research shows that the two most important stakeholders, governments and shareholders, are moving in different directions. Businesses respond to the wishes and demands made by shareholders and governments. Without any pressure, there is no sense of urgency to change operations. This creates a mentality of 'do not fix what is not broken'. The call for sustainability has been increasing steadily over the last decade, and policies are being put into place to force companies to apply sustainable efforts such as circular production and sourcing. This is in line with findings from (Lahane et al., 2020) that say the importance and interest are growing. The regulations, such as the PPWR, all have a long period for companies to adhere to and are only active for European markets. This trend is to hold companies accountable for the resources they use and create responsibility in reaching targets. Stakeholder pressure has a positive impact on implementing circular practices, closed loops for packaging are the main application that comes from regulations. The results also showed that within supply chains, they are aware of the need to gradually change. Currently, an overhaul is too expensive, which is why regulations allow for years of accustomisation to reach targets. If the shift is made too late, the result is a heightened risk of losing market position. Other stakeholders do not amount to sufficient pressure to force the implementation of circularity. The shareholders are focused on profit in the short term and therefore see no value in investments that only generate a profitable return after multiple years. Scarcities worldwide and the need to use resources effectively cause regulations to be drawn up, which in turn leads to the implementation of circular practices. However, the successful implementation of circularity depends not only on regulatory enforcement but also on an alignment with other stakeholder interests toward long-term developments. The result of the misalignment is a sluggish implementation with the core business processes remaining unchanged.

Lastly, supply risk, the other mediating factor, whilst important to profits and impacted by scarcity events, does not lead to the implementation of a circular supply chain. The lack of natural resources heavily impacts the ability to conduct business and complete orders, but the risk is accepted and is being solved through other methods. The most common strategy is to build up safety stock to work through the most pressing issues. While safety stock is used, the search for alternative suppliers and spot market behavior is utilised. The methods have been declining in effectiveness (Bell et al., 2012), but are currently still used most often. These strategies are undesirable as they cause quality issues, as the current suppliers have a long-lasting partnership and have the necessary specifications. Another undesirable effect is that contracts are established for the long term, thus price is regulated. During scarcity, prices skyrocket, and when the current supplier cannot meet the needed demand, the cost of materials increases. Scarcity events, however, do not occur regularly enough to warrant a change towards a closed-loop system. Projects in reusing waste are sought out, but not with any urgency. It is beneficial if the projects are a success it would only alleviate risk slightly, as the operations are built to need new raw materials. Large companies need a standardised process to reach the required demand, which makes a change in handling storage capacity, processes, and supply increasingly difficult. Next to that, FMCG was the main industry that was interviewed, and for them, it is difficult to reuse resources since the end product is consumed. If resources are contaminated by an error in the supply chain, they cannot be reintroduced, as it would fail to comply with safety regulations. Although supply risk affects operations during scarcity, it does not occur frequently enough to drive the adoption of circular supply chain practices.

The theorised framework *(chapter 2.3)* is not supported by the findings. The proposed relationship between resource scarcity and circular supply chain implementation is very weak. The supply risk is impacted by resource scarcity, but the higher risk does not impact circular supply chain implementation. The stakeholder pressures can be split into 2 different groups; The governmental policies are affected by resource scarcity and impact circular supply chain implementation. Shareholder pressure is opposite, as they are not affected by resource scarcity, and cause companies to stay with current processes. The mediating factors aid the connection between resource scarcity and circular supply chain implementation, but the impact is too

low for a clear relationship to be visible, given the collected results.

5.2 Contribution to literature

Firstly, the research showed that the barriers to change are higher than the perceived benefits companies acquire from changing their operations to employ circularity across the entire supply chain. Previous studies into the negative effects of scarcity could potentially be offset by the profits that arose from research about circular supply chains. The results have shown that current barriers are more impactful than the potential perceived benefits. Such barriers are the infrastructure of a business or the potential risks that were discussed by (Bressanelli et al., 2019), (Zeng et al., 2016). This is further backed up by the importance of aligning with stakeholders to invest in looped systems (Williams, 2019). While governments force companies to adhere to policies, the stakeholders that hold the most power are owners. With circularity being new and data often being theoretical, the motivation has to be intrinsic to pursue the implementation of circular practices. (Zeng et al., 2016) (Morseletto, 2020) (Lieder & Rashid, 2016) and (Wang & Azam, 2023) all found that circular practices can lower risk and disruptions. With the results collected, the only companies not to suffer extra risks are those with circularity, which aligns with the findings made previously. For the literature, this implies that case studies that provide more information are a necessity to show the long-term effects. Current research, including this thesis, focuses on resource scarcity, but to understand the full extent of scarcity, more research into expected resource scarcity has to be done (Lianos, 2022). The harm current risks cause is accepted compared to an overhaul of processes, as future implications are unknown. Small companies start with circular practices as a core of their operations, but existing firms are reluctant to change.

Secondly, the research shows that there is a high awareness of circularity amongst company executives and a willingness to implement changes to have more control over vital resources. However, there is no sense of urgency, and thus, scarcity is loosely affiliated with the implementation of circularity. There is an increased attention that, at the moment, fails to lead to impactful changes. The supply risk is heavily affected by scarcity, but older strategies such as spot market buying and usage of high safety stocks are still used most often. The current market promotes competition over cooperation (Siderius & Zink, 2023) as financial benefits are obtained by control over scarce resources. This thesis has identified that resource scarcity has no direct impact on the implementation of circularity in the supply chain.

5.3 Managerial implications

Managers can find value from this thesis by seeing the consequences and decisions mapped out when dealing with scarcity. Resource scarcity is a growing problem, and companies that are more resilient in scarcity events and have less dependence on new raw materials entering their operations will ultimately have a competitive advantage. A gradual transition toward circularity not only mitigates the risks posed by resource scarcity but also positions businesses for long-term resilience and a competitive advantage for the future. Managers can see that laws and directives will create pressure to adopt sustainable practices such as circularity. Compliance with regulations can be achieved by adopting elements over time and creating a smooth transition period. The importance of a careful evaluation of processes is necessary, and slightly higher costs will sometimes have to be accepted. To further evaluate the extent to which scarcity affects the business, the entire supply chain has to be analysed. RE-NL1 mentioned that in large supply chains that have multiple stages, scarcity can unknowingly affect operations. A more in-depth analysis of where scarcity affects output is important to find the best solutions. The current situation is that scarcity increases the competitive nature of the market, and prolonged scarcity harms operations and relationships with suppliers and customers. The results show that current risk mitigation strategies, whilst harming the ability to conduct business, are more common and effective for large businesses that have multiple tiers within their supply chain and a standardised production process. If costs are similar, the circular option can offer more agility in times of scarcity and is future-proof. Therefore, the main takeaway is that pursuing the current strategies is sufficient, but a further analysis into the impact of scarcity can show more effective measures, and the steady transformation of the supply chain is necessary to stay competitive in the future.

5.4 Limitations

The research does have multiple limitations that could have skewed results. Firstly, interviewees worked for large companies that are active in multiple countries, which meant the supply chain consists of many different elements and therefore interviewees did not always have details about the entire process of material usage. The researcher provided a nice baseline but from the 8 other interviewees only 1 had long-term experience with circularity but joined the company after COVID-19 when the supply was under the most pressure and thus never experienced disruptive effects of scarcity, therefore another circular company would have been beneficial to corroborate findings. The interviewees were also not experts in circularity and sometimes proceeded by answering questions about their emission goals, since it also aligned with sustainability. With open-ended questions, it is more difficult to classify responses as experiences differ per industry, and more volatile markets could have a different threshold for when shortages are officially seen as a scarcity event. Lastly, there was a large focus on the FMCG industry as they were willing to participate more. This has caused the results to be skewed towards a specific industry instead of creating an idea of how scarcity affects circular implementation across the entire business scheme.

5.5 Future research

Future research could look into finding a better mixture of circular and non-circular participants and look to interview multiple people per company so that the multiple tiers of the supply chain are well represented in the results. Future research could also differentiate the stakeholders into different groups and allocate the most powerful groups and how they impact the implementation of circularity, as this research has shown that within the group of stakeholders, different interests exist. Lastly, research that studies multiple businesses in the same sector, with a clear differentiation between circular companies and non-circular companies, and examines their methods of handling scarcity. From this research, a clear result can be found with respect to how circular supply chains aid in handling resource scarcity.

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8. APPENDIX

Appendix 1: Interview scheme researcher

Section	Question	Goal
Background	Could you please explain what you do as a researcher	Information about interviewee
	With how many organisations do you conduct your research and across how many different sectors are they active?	Information about interviewee
Scarcity Experience	Have you studied the effects of scarcity and the impact on the supply chain?	Information about scarcity
	What are common effects caused by scarcity on businesses?	Impact of scarcity
Response to Scarcity	What measures were taken to avoid the impact of scarcity in the future?	Information about handling of scarcity
	What measures are deemed the most effective?	Information about handling of scarcity
Circular Supply Chain Exploration	Have you seen an increase in people seeking partnerships or information about circular supply chain recently?	Information about circular trends
	How has scarcity influenced the adoption of circular practices?	Relationship between scarcity and circularity
	What are reasons for companies to adopt/neglect circular supply chain practices?	Determine factors that contribute/withhold change
External Pressures	Is there a shift in how stakeholders react to companies that refuse to invest in circular supply chain?	Impact of stakeholders
Supply Risk	What factors of scarcity causes supply risk	Relationship supply risk and scarcity
	How can circularity alleviate this risk?	Relationship supply risk and circularity
Outlook	Do you think circular supply chains will become standard in your industry in the next 5–10 years?	Explore long-term vision and expectations
Wrap-Up	Are there any further comments you would like to make?	Allow for more information to be given