

HOW COULD A CIRCULAR SUPPLY CHAIN MANAGEMENT HELP TO ADVANCE CIRCULAR ECONOMY?

Trabajo Final de Máster

Máster Universitario en Logística, Cadena de Suministros y Negocios Marítimos
Tecnocampus Mataró, Universitat Pompeu Fabra

Stephanie Feger

Jesús E. Martínez Marín

2022



Centre adscrit a:



Sustainability is a crucial topic globally, so it is necessary to adapt human life to the necessity of the Earth because it is already harmed severely. Therefore traditional economy cannot be continued like that ,and companies must change their processes to become more circular. However, implementing a circular economy is tricky and needs a lot of time and patience. New business models must be designed, and even supply chains must change. Hence, collaboration in a supply chain becomes essential to create a circular one. If this step is done, the economy could change and start closing loops and getting circular.

Key Words: Sustainability, Linear Economy, Circular Economy, Business Models, Circular Supply Chain, Collaboration, PESTEL Analysis

Index

Index	3
Table Index	6
Figure Index	7
1. Introduction	9
2. Sustainability	10
2.1. What is sustainability?	10
2.2. Effects of supply chain management on the environment	12
2.2.1. Climate Change	12
2.2.2. Emissions	15
3. Linear Economy	17
3.1. Definition	17
3.2. Economic Risks	19
3.3. Ecological Disadvantages	22
4. Circular Economy	24
4.1. Definition	24
4.2. Circular Business Models	28
4.2.1. Value proposition	30
4.2.2. Value Creation and Delivery	30
4.2.3. Value Capture	31
4.3. Difficulties in the implementation	32

5. Reverse Logistics	37
5.1. Principles of Reverse Logistics	37
5.2. Opportunities	41
5.3. Challenges	44
6. Circular Supply Chain Economy	47
6.1. Definition	47
6.2. Introducing circular economy in the supply chain	50
6.3. Barriers of circular supply chain management	53
6.4. Important characteristics	54
6.4.1. The power of inner circle	55
6.4.2. The power of circling longer	57
6.4.3. The power of cascades	58
6.4.4. The power of pure inputs	59
6.5. Four archetypes based on the concept of geography	59
6.5.1. Closed & global/local/regional loop	61
6.5.2. Partially open local/regional loop	64
6.5.3. Open cascade	64
6.5.4. Linear	65
6.5.5. The best option for a circular economy	65
7. Importance of collaboration within a circular supply chain	67
8. PESTEL-Analysis	73
9. Results	84

10. Conclusions _____ **84**

References _____ **85**

Table Index

1. Typical stages in a generic supply chain (Bianchini et al., 2019)

Figure Index

1. Studied industry and sectors (Ghadge et al., 2020)
2. Climate Change impacts to supply chain links (Dasaklis & Pappis, 2013)
3. A traditional linear value chain (Jørgensen et al., 2018)
4. in Commodity Markets (Bakas & Triantafyllou, 2020)
5. Linear supply chain of a present organization (Manavalan & Jayakrishna, 2019)
6. The 9R Framework (Kirchherr et al., 2017)
7. HP EcoCycle Cartridge vs. NBC Cartridge (For Elements Consulting, 2021)
8. Comparison of traditional, sustainable, and circular business models (Geissdoerfer et al., 2018)
9. A value-based view on the sustainability of circular business models (Geissdoerfer et al., 2018)
10. Return reasons for reverse logistics (de Brito & Dekker, 2004)
11. Reverse logistics processes (de Brito & Dekker, 2004)
12. Driving triangle for reverse logistics (de Brito & Dekker, 2004)
13. Four sources of value creation for circularity (Yang et al., 2018)
14. Traditional, sustainable and circular supply chains (de Angelis et al., 2018)
15. Basic cascading example (Campbell-Johnston et al., 2020)
16. Simplified bill of materials of a power drill (WEF, 2014)
17. Archetypes of supply chains and loops (WEF, 2014)
18. Global Container Trade (DHL, 2022)
19. Loop of returnable bottles (AK Mehrweg GbR, 2022)
20. Linear, closed-loop, and circular supply chains (Farooque et al., 2019)
21. Types of relationships (Kampstra et al., 2006)
22. The ladder of collaboration (Kampstra et al., 2006)
23. Have you ever heard about circular economy or reverse logistics in general?
24. Has the Corona Pandemic affected the reverse logistics or rather the sustainability in general of your company?
25. Has the Corona Pandemic affected the reverse logistics or rather the sustainability in general of your company?
26. If yes, which challenges are you facing by implementing reverse logistics or rather circular economy?

27. Are you planning to invest more money in sustainability and circular economy?
28. How important is sustainability in your company?
29. Is sustainability part of your company's Code of Conduct?
30. Do you have any climate targets within your company?
31. Are you using new technological tools to provide a more fluent circular economy?
32. Do your drivers use their tours to collect waste products?
33. Are these sectors interested in giving back their waste products directly to the supplying logistics company?
34. Does your company also take back the packaging of the delivered products?

1. Introduction

Every year there is a so-called Earth Overshoot Day. Last year this day was already on the 29th of July (Earth Overshoot Day, 2021). An Earth Overshoot Day means, for example, that humans have consumed natural resources that are supposed to be for one year, entirely on the 29th of July (Ramakrishna, 2021). Every year Overshoot Day is on an earlier date, except for 2020, due to the corona pandemic because there were lockdowns worldwide, so CO2 emissions were reduced drastically. That shows that sustainability is getting more important nowadays, and activists like Greta Thunberg are receiving much more attention and are raising global awareness.

Sustainability is crucial in the private sector and the corporate sector as well. Therefore, it is receiving more importance than ever. There are two different economic approaches: one is called linear economy, and the other is called circular economy.

For this reason, this thesis aims to comprehend the circular economy better and demonstrate its advantages over a linear economy, outpointing sustainability. Furthermore, it focuses on transferring circular economy to circular Supply Chain Management. Hence, a survey will be organized with German logistic companies to identify to what extent the circular economy has arrived in their logistics.

The thesis will first cover sustainability in general and explain linear and circular economies accordingly. Then it will talk about how a circular economy can be adapted to a circular supply chain management and how important a whole collaboration between the actors is.

2. Sustainability

2.1. What is sustainability?

There have been more than 140 definitions of "sustainability" in the last two years. Nonetheless, in the opinion of Johnston, sustainability can only be reached if all aspects of the economy, environment, and social well-being are served at the same time. Therefore, he thinks there should be no dedicated definition of sustainability in different sectors. That means that, for example, there should not be an extra definition of sustainable agriculture or sustainable logistics (Johnston et al., 2007).

Nevertheless, looking up "sustainability" in previous dictionaries indicates that an action or an activity is capable of being sustainable. Of course, this definition must be reconsidered because it does not review the whole topic environment. The dictionary's definition would contain that even severe damage could be considered sustainable because it is just measured in a certain amount of time and the human span of life is very short in comparison. Other people are convinced that there is no need to worry about the environment since ecosystems adapt to extreme damage after a period. That is true, but human beings are developing very fast, and the destruction is getting worse, so ecosystems have never been facing such damage in such a short period (Johnston et al., 2007).

An example is the accident of the supertanker Torrey Canyon in 1967. It was the first significant oil spill, with 119,000 tonnes of oil leaked into the sea. However, after decades it was still noticeable (Wells, 2017). It is generally agreed today that humans will never be able to see all impacts of the damage they have caused on Earth because the span of life is just too short.

Therefore, it is necessary to realize that ecosystems and the environment need to be protected because the damage already caused by human activities cannot be taken back, and society must live with it as it is now.

So, nowadays, there are a lot of different definitions, but as mentioned before, they are always related to specific sectors or individual groups' opinions (Johnston et al., 2007).

To cut a long story short, the Swedish scientist Karl- Henrik Robert aimed to define sustainability which is used in literature and accepted by many other scientists. It is published under the name "The Natural Step Framework". This definition is quite complex and will be explained partly for this thesis to get a better understanding of a good definition. For this reason, Robert defined so-called system conditions, which are declared as follows:

"In the sustainable society, nature is not subject to systematically increasing...

... concentrations of substances extracted from the Earth's crust

... concentrations of substances produced by society

... degradation by physical means and

People are not subject to conditions that systematically undermine their capacity to meet their needs." (Missimer et al., 2010)

These four system conditions show how the Earth should work with a sustainable society. That means that one of the conditions is dedicated to human needs, and the other three conditions are created to explain the interactions between humans and their planet. Accordingly, the conditions describe that natural processes on Earth hold up humans' life, so it is possible to live for them like photosynthesis or air purification.

The issue is that humans are changing these conditions by using too many natural resources too fast. The natural step system of Karl-Henrik Robert wants to define this exact problem (Missimer et al., 2010).

These system conditions define sustainability in general by establishing a framework for society, economy, and environment that are intertwined with each other. Robert tries to create a scale with his system conditions in which national and regional governments, agencies, businesses, and NGOs must take responsibility to work together and think about a definition of sustainability that scientists would accept. This definition should not cover specific sectors but generate a definition that includes sustainable development (Johnston et al., 2007).

Regarding Geissdoerfer, Morioka, de Carvalho, and Evans, sustainable development is defined as follows:

"Sustainable development aims at satisfying current needs without harming future generations' ability to satisfy their needs (WCED 1987), while considering limitations in the Earth's resources in face of human development (Meadows et al. 1972; Meadows, Randers, and Meadows, 2004), as well as synergies and trade-offs between economic, environmental and social goals (Elkington 1997)."

2.2. Effects of supply chain management on the environment

2.2.1. Climate Change

Nowadays, climate change is one of society's biggest challenges and even concerns the most untouched regions on Earth. Moreover, it progresses faster than scientists assumed a few years ago.

Nevertheless, what does climate change exactly mean?

"Climate change is defined as a change in the state of the climate that can be identified by changes in the mean and variability of its properties and persists for extended periods decades or longer." (Ghadge et al., 2020)

That means that climate change is reflected in more severe storms, rising temperatures, heatwaves, floods, drought, or cold spells – those are just a few examples of the consequences.

Because of these extreme weather conditions, the effects of climate change have been an enormous matter of expense for companies in the last few years. This topic is so crucial that the most influential politicians of almost every country are coming together to discuss the impact of climate change. They are trying to reconsider solutions to reduce or minimize climate change damage (Ghadge et al., 2020). For example, in 2015, most countries signed the Paris agreement. In this agreement, countries declared that they would minimize future environmental damage and reach the targets like limiting global warming to a maximum of two degrees (Dash Wu et al., 2019). Of course, these approaches are seen in the daily and global business and supply chains. It is one of the

most critical topics for decision-making, in business, and for private individuals. Future managers of supply chain departments must understand climate change and that its risks are constantly growing. In some definitions of supply chain management, it is even included that supply chain is about risk management. Climate Change is one of these risks, and its impact can still not be foreseen these days. There are just some of the assumptions made by different scientists (Ghadge et al., 2020). One of the unseen impacts was the corona pandemic. Climate change boosts the spread of diseases, and the corona pandemic severely affects the supply chain and its future.

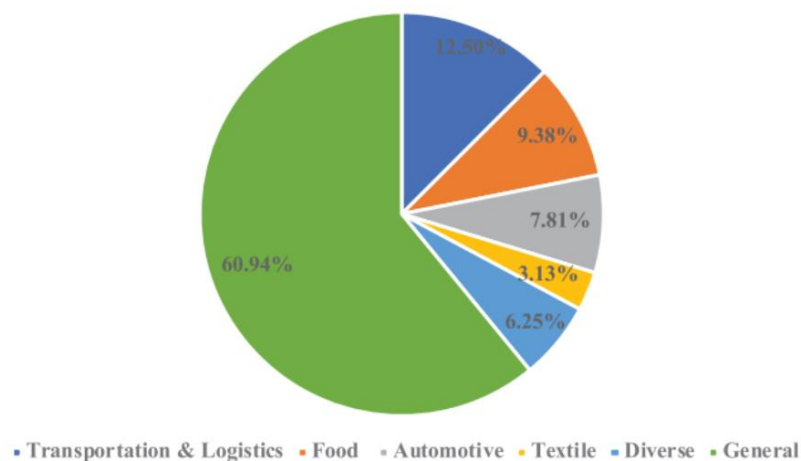


Fig. 1: Studied industry and sectors (Ghadge et al., 2020)

The above figure shows how climate change affects the supply chain of different sectors. The most significant impact of 60.94% is general and does not address a specific industry sector. Thereafter, is already listed the transportation and logistics sector with 12.50%. Climate change has a remarkable impact on this sector because natural resources like fuel are getting more difficult to extract and become more expensive. The food sector is also related to climate change because of the extreme weather conditions of the last decades. That means the harvest time is altered, or the crops are withered or flushed away (Ghadge et al., 2020).

Climate change is not only affecting the supply chain but also its links. In the table above, it is explained which links are disturbed and how. Nevertheless, it needs to be said that these links also provoke climate change.

Supply chain links	Typology of climate change impacts/risks
Manufacturing	<ul style="list-style-type: none"> • damage or complete destruction of assets • liability risks • disruption of plants and production lines • regulation with regard to carbon emissions • changes in the effectiveness or efficiency of production processes • increased costs for energy and maintenance activities • increased cost of upstream operations and product quality • stimulation of investments in renewable energy and energy efficiency projects increase in demand for biofuels and renewable energy sources in the energy sector • increase in demand for pharmaceuticals' sector • stimulation of demand for non-emitting products • deployment of lower carbon intensity operating practices by market leaders development of diversified products based on lower GHG emissions
Transportation	<ul style="list-style-type: none"> • increase in buckled rails and rutted roads • delays leading to paying compensation to operators and causing problems to customers • overhead cables brought down because of strong winds • problems related to coastal defences • drainage issues • landslip resulting from heavy rainfall • securing stability of structures
Warehousing and storage	<ul style="list-style-type: none"> • vulnerability of infrastructure, personnel, communications, supply etc • possible dislocation due to extreme weather events
Trading	<ul style="list-style-type: none"> • reputational risk in downstream sectors due to increased need for transparency • new regulations regarding product labeling • increases in the consumer goods production costs and prices • decrease of demand for consumer products
Consumption and Customer Service	<ul style="list-style-type: none"> • need for improved product design aiming at the elimination of packaging material and the enhancement of product durability, reusability, recyclability, and materials efficiency

Fig. 2: Climate Change impacts to supply chain links (Dasaklis & Pappis, 2013)

Manufacturing interferes with the environment because the production lines to produce the products require much space; therefore, much-untouched land will be covered with plants. Countries in Asia have truly diverse fauna and flora, but they offer cheap land so companies will build new facilities there. Hence, it is cheaper for companies to produce in these countries because there are fewer regulations about protecting the environment. However, the result is that these facilities can be damaged by extreme weather conditions caused by climate change. For example, monsoon rains are getting heavier and are disturbing the production lines.

Transportation is the most apparent source of emissions and contributes to climate change. Nowadays, transportation routes are exceedingly long and time-consuming. Mostly ships and trains are used, which are manipulated relatively easily by nature. Rails are damaged by heat, intense rainfalls, or winds, while ships could get problems through drought and dropping of the stream gauge (Dasaklis & Pappis, 2013). For example, the Panama Canal cannot operate entirely during the dry season because the barrier lake has not had enough water, so the present-day ships, which are very heavy, cannot pass (Simonit & Perrings, 2013).

Warehouse and storage engage much space and absorb much energy to run it. For instance, some products always require a constant temperature. Moreover, these buildings are influenced strongly by extreme weather conditions. Therefore, they also have high costs of insurance.

Trading is very regulated nowadays to mitigate climate change. That implies that products must be labeled more accurately, particularly the food industry is affected.

The last link of the supply chain is **consumption and customer service**. They are the supply chain's output and directly concern the end customer. If the end customer has consumed a product, much waste remains, for example, plastic waste. Scientists estimate that around 10 million tons of plastic waste are in the oceans. Due to the corona pandemic, this has worsened dramatically because people have been wearing single-use masks in the last two years. Now companies are responsible for designing their new products so that the used plastic can be recycled and a cycle can be created (Dasaklis & Pappis, 2013).

The following bullet points will explain why a sustainable supply chain is essential and a competitive advantage.

2.2.2. Emissions

As mentioned before, one of the climate change triggers is emissions. Manufacturing and supply chains are the biggest polluters of carbon emissions. More than 90% of emissions can be found in a company's supply chain (Shaharudin et al., 2019). In 2014

the United Nations released some interesting facts regarding transportation and emissions. For example, 22% of worldwide carbon dioxides are caused by transportation corresponding to the UN. Additionally, it creates 19% of black carbon, which significantly damages the environment and human health because it can, for example, provoke lung cancer (Rehman Khan et al., 2018).

That is why companies are pursuing a low carbon supply chain, a strategic initiative related to the environment. This initiative aims to reach operational excellence and reduce costs by working more efficiently and reducing carbon emissions. The initiative must be applied to the four areas of the supply chain:

- Procurement
- Productions process
- Product
- Logistic

This initiative can only be successful if the departments communicate, share, and collaborate constantly. So, a business process in the supply chain can be implemented to react fast and efficiently to market inquiries (Shaharudin et al., 2019).

When designing its supply chain, a company should already consider the consequences of emissions. Thus, damages or political regulations could be encountered in the beginning. So, the supply chain strategy should consider the effects of emissions on the aspects of the supply chain design. Some points will be described in the following:

Facilities should be built as near as possible to the end customer. Accordingly, transportation costs will decrease, and the emissions will also be diminished enormously.

Sourcing should be considered to what extent natural resources are available. In addition, it is vital to know the extraction costs and if the quality is fine. Therefore, one of the main goals is to find local suppliers with which it is easier to collaborate and find solutions to mitigate emissions.

Transportation and distribution can participate in reducing emissions if the means of transport are renewed, referring to their drivetrain. For instance, electronic or hybrid engines cause less CO₂ emissions than traditional ones. Although it should be considered

that the battery of electronic cars is also harmful to the environment, a solution should be found to dispose of them properly. Other aspects are to show the drivers how to drive environmentally friendly and to plan their routes so that the total mileage will lessen.

Product design is significant to consider in declining emissions. It must be thought about which materials will be utilized, where they will be purchased, and the whole production process must be well controlled. Additionally, the package must be reviewed and how much waste it does create or if it is possible to recycle.

Finally, the **supply chain configuration** should be revised if it is better to be centralized or decentralized. For example, the whole just-in-time concept is causing an extremely high output of emissions, wherefore it is damaging the environment and is not contemporary anymore (Dasaklis & Pappis, 2013).

One solution to reducing CO2 emissions in a supply chain without further costs could be to reduce the order quantity, and the wholesale price must be changed (Dash Wu et al., 2019). The following bullet points will describe how different economic aspects influence sustainability and how society and companies can contribute to improving it.

3. Linear Economy

Sustainability nowadays is more crucial than ever. Climate change advances faster than scientists thought. One reason for that is society's misuse of natural resources. Especially the economic model, which is accepted globally - linear economy.

3.1. Definition

Now, this thesis focuses on finding a definition for the linear economy. It is still the traditional model for most companies. One typical characteristic of a linear economy is the destruction of the product at the end of the product life cycle (Didenko et al., 2018).

Therefore, this economic model is one of the main reasons that resources on the Earth are used faster than ever before. As mentioned in the introduction, this explains why Earth Overshoot Day shifts forward every year.

However, the simplest definition of linear economy is "take, make and dispose". It is based on the linear value chain and means that, for example, an end customer purchases a candy bar and eats it entirely, but the plastic package remains. The customer will throw away this package, and it leaves plastic waste. That is why a linear economy is consuming too many natural resources of the planet and producing tons of waste (Jørgensen et al., 2018).



Fig. 3: A traditional linear value chain (Jørgensen et al., 2018)

The linear economy can be compared to a river meaning that raw materials must always be added to keep the flow running. So, it exists because humans keep buying products due to the substantial influence of fashion, emotions, and progress (Eisenriegler, 2020). It is their nature to want the newest and best products on the market.

The linear economy was established during the third industrial revolution. Many countries' economies proliferated and reached their wealth because of this approach. Nowadays, an unequal allocation of wealth is geographically triggered by a linear economy (Sariatli, 2017). Nevertheless, this decades-long exploitation leads to a moment that natural resources like fossil fuels will vanish someday (Jørgensen et al., 2018). The problem is that present-day society counts significantly on these resources, particularly logistics.

For this reason, society must find a solution to renew the linear economic model, so Earth can recover, although the damage is already too severe. Therefore, this thesis will explain now which economic and ecologic challenges a linear economy implicates. Furthermore, it wants to show why applying a new economic model is urgent.

3.2. Economic Risks

Firstly, this thesis will talk about the economic risks. There are risks because the linear economy is expensive, wherefore the wholesale price is increasing. Additionally, the linear model works just fine in an unsaturated market. These points will be described more clearly below.

Expenses of the linear economy

In 1900 the gross world product was EUR 2.5 trillion and increased to EUR 14.5 trillion. In 2017 it even reached EUR 60.4 trillion. Therefore, material consumption rose rapidly from 26.7 billion tonnes in 1970 to 92.1 billion tonnes in 2017. Scientists suppose that until the year 2050, this number will even double (Baran, 2019). According to the Sustainable Europe Research Institute (SERI), companies used 21 billion tonnes of materials during production, which were not included in the end product. These materials got lost through inefficient processes, storage problems, or the transformation of material form. In 2010, 65 billion tons of volume of materials flowed into the European economy, as reported by Eurostat in 2011. Only in Europe, 2.7 billion tons of this material were wasted and needed to be thrown away. That means that 4 % of the material will not be used and is just lost instead of finding a way to bring it back into the economy. At least 26 billion tons stay in the circle and will be renewed through recycling, for example (Sariatli, 2017). Of course, society and the economy are losing tons of energy and resources. Therefore natural resources are getting rarer by the time. All will be wasted one day if this material waste does not flow back into the system because resources are finite.

Nevertheless, a linear economy depends on cheap and sufficient energy and is only successful because society is very short-sighted. That means that humans want to satisfy

their needs immediately, and companies also target profit in the short term. One example of typical human behavior is clearing woods to gain new ground. This ground will be farmed for a few years and will get unfertile. In return, the trees spent fresh air and saved people from landslides. Due to climate change, there are more extreme storms though in this case, humans just saw the fertile ground and nothing else (Eisenriegler, 2020). This example explains how humans satisfy their needs without thinking about future consequences.

A general increase in wholesale price

If resources are tight, but the demand increases, the price will rise because there is not enough offer regarding the easily understandable microeconomic system.

The figure below shows that oil, a fossil fuel, fluctuates intensely. Its commodity price depends on what is going on in the world. For example, in 2008, there was a banking crisis, so the oil price rose rapidly (Davis & Karim, 2008). Commodity prices, in general, are affected, although the fluctuation is not that severe but noticeable. Gold's variation does not jump that high because gold is usually not used for daily products, but humans mostly need oil to drive or heat. The supply chain is also concerned because high oil volatility means high transportation costs, for instance. A linear economy stimulates commodity price volatility because many natural resources are wasted and do not flow back into the economy. If they would bring back these resources, the fluctuation of the prices could be diminished.

The figure also displays that the fluctuations before 2010 were not that perceivable, so the material costs were more stable than before. However, after 2010 they got a virtuous cycle and fluctuated strongly. So, material costs are rising because the demand increases as well constantly. Third World Countries are climbing the social ladder and becoming so-called emerging nations. Therefore, the middle class is growing fast (Sariatli, 2017). For example, the world population grew from 1.6 billion to 7.6 billion between 1900 and 2018 (Baran, 2019). However, elevated demand in the last decades has led to higher production costs. It is also getting more challenging to gain natural resources because their locations are more problematic to reach. On the other hand, the competition gets more intense, so the end customer does not notice the price increase

because companies must keep their competitiveness. So, the linear economy starts to be more disadvantageous than before (Sariatli, 2017).

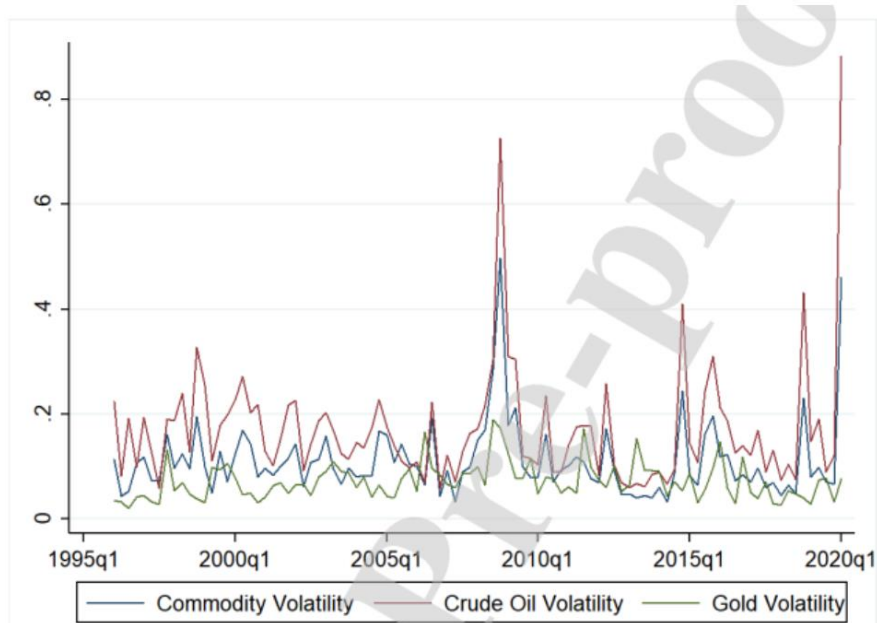


Fig. 4: Volatility in Commodity Markets (Bakas & Triantafyllou, 2020)

Non-saturated market

The linear economy has more success in non-saturated markets like in the beginning of the third industrial revolution. This type of market implies a strategy to overcome shortages of goods, food, or living space. For example, the goods market is almost non-saturated, like cars. The market is saturated if the number of yearly scrapped cars is near the number of sold new cars. The market is still producing new cars, but society is not gaining more mobility or prosperity. The new cars are just replacing the old ones. Producing new cars means that companies are using newly gained natural resources without giving the used natural resources back to the economy. The production of the new cars becomes more expensive than before because companies must gain new natural resources from the ground, which could be strenuous.

3.3. Ecological Disadvantages

The current linear economy model, which is based on "take, make and dispose" shows the first indications that it has reached its limits. Earth is warming up, and the natural resources that society depends on will get short. Scientists suppose that in the next 15 years, the demand for natural resources will increase by another 50% (Eisenriegler, 2020). So, society needs policies to change the linear model because this approach could lead to ecological destruction in the future. This damage would be impossible to reverse. However, the problem is that the world population is constantly soaring with their wealth, so humans are consuming even more (Didenko et al., 2018).

The most ecological disadvantage of a linear economy is pollution, which rapidly advances climate change. The planet's ecosystem has changed excessively fast that it cannot be stopped or improved. This disadvantage is one of the alarming outcomes of the higher demand for natural resources.

Global plastic production is one descriptive example of the linear economy in the supply chain and its pollution. In 2017 companies manufactured 348 billion tonnes of plastic, and by 2040 it will be doubled (Baran, 2019). In the following figure, a simplified linear supply chain of plastic production is pictured:

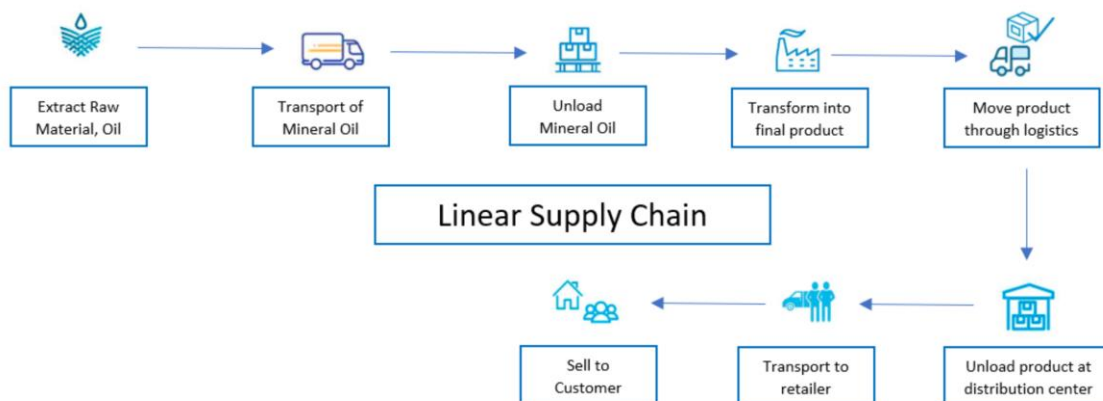


Fig. 5: Linear supply chain of a present organization (Manavalan & Jayakrishna, 2019)

Plastic is extracted from the raw materials of natural gas, coal, and mineral oil, of which mineral oil has the most significant share. After the mining, these materials will

be transported and unloaded in the company's facility. It will be transformed into the final product, in this case, plastic. The product will be moved through logistics and unloaded at the distribution centers. Then the plastic will be transported to the retailer, selling it to their customers.

Plastic could establish itself amazingly fast because the production is economical. Moreover, the material is multifunctional and utilized chiefly in households, packages, or the electronic industry. Therefore, the demand increased excessively. In the linear economy, it is typical to use plastic which means it is produced so that it can be consumed just once. Households are creating 64% plastic waste due to packages, for example. Trading and the industry are responsible for the rest of the plastic. 60% of the entire usage of plastic is single-use plastic. Nowadays, companies try to create a loop and recycle plastic, so it will not pollute the environment anymore. Mainly plastic pollution affects the oceans. More precisely, 80% of the single-use plastic ends up in the sea. Since 1980 150 million tonnes of plastic have been thrown into the oceans. As mentioned before, that is damaging and alters the ecosystem remarkably. Humans are concerned because plastic is getting into the food chain (Manavalan & Jayakrishna, 2019). Recently, scientists found out that microplastic was in the blood of human beings.

The linear economy model is responsible for these ecological consequences. Earth cannot process with such a model anymore, and even the economy cannot handle this rapid development of the global population and its demand. The concept of the linear economy must change because the demand cannot be attended directly. Manufacturing needs to improve production so humans will cause less waste. Moreover, the supply chain should create a loop to prevent more damage and these consequences. The following bullet point explains what it means to "create a loop," meaning to become a circular economy—additionally, which different models exist and what implementation difficulties occur.

4. Circular Economy

As described in this thesis, the Earth, human society, and the economy cannot exist much longer if they apply the linear economy model. It must be changed, so natural resources will not be wasted anymore. So, they need to get back into the system.

4.1. Definition

Therefore, a circular economy would be the answer. That is why the thesis focuses on a definition of circular economy in this bullet point. A proper definition requires an entire framework. This framework for a circular economy should contain the following aspects:

Core principals

There are two different approaches to the core principles. On the one hand, the R frameworks, and on the other hand, there are the system perspectives. The R frameworks are core principles because they clarify the "how-to". The European Union uses mainly the 4R framework. However, what is the meaning of R frameworks?

All different R frameworks (frequently there is a 3R, 4R, 6R, or 9R) have the commonality that they are based on hierarchies. For instance, 4R starts with the first R (reduce), which is the closest to preventing waste and is on the highest hierarchy level in this framework. The following R is one level below because it produces more waste and is closer to a linear economy. This concept is established on the recycling approach, but "most recycling is actually downcycling; it reduces the quality of a material over time" (Kirchherr et al., 2017). Therefore, the 4R theory should be at least expanded, so the quality of recycled materials remains constant. Moreover, an improvement of the theory is also to be considered.

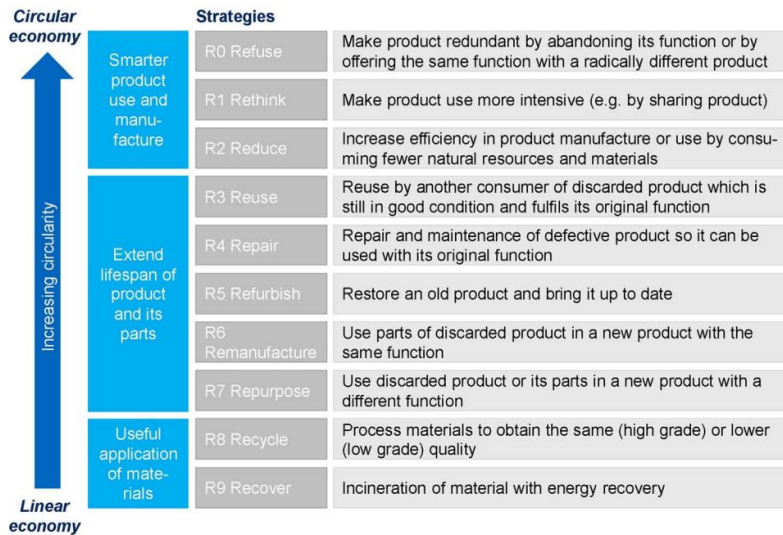


Fig. 6: The 9R Framework (Kirchherr et al., 2017)

The above figure shows the mentioned hierarchy in a 9R framework. In the below part of the list, the Rs begin to transform the linear to a circular economy. For example, recycling (R8) means that the product's material will be reused without losing the quality, but exterior materials are still used to produce the end product. On the other hand, a closed circle without many external influences is reached when a product is rethought (R1). That implies that the material quantity and the effort are reduced to a minimum.

One example of a product that has achieved the level R2 (Reduce) is one of HPs newest cartridges. This cartridge is called HP EvoCycle Cartridge. It is specific because HP is renewing the cartridges in a facility in Brittany, France. At the moment, it is a pilot project on the French Market.

The below figure describes the supply chain for EvoCycle cartridges and NBC (New Build Compatible) cartridges:

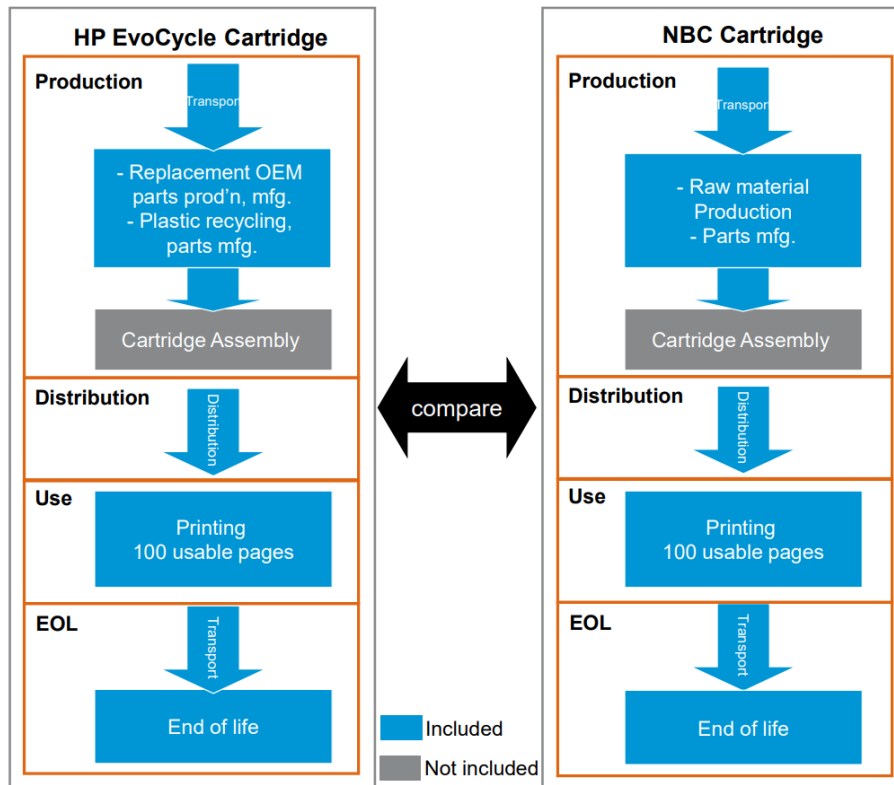


Fig. 7: HP EcoCycle Cartridge vs. NBC Cartridge (For Elements Consulting, 2021)

The two supply chains are compared, showing that the distribution, use, and EOL (end of life) part is the same. The difference lies in the production. NBC production uses raw materials, so it equals a linear economy. However, EvoCycle utilizes originally used cartridges sent to France from the end customers. There the old cartridges are disassembled, inspected, and cleaned. The cartridge is made of plastic that is obtained from a closed loop of used HP products. HP sees its responsibility that the quality of the product remains constant, so it will not be downcycled as with the NBC cartridges.

Moreover, these cartridges were tested to see if the print quality was as good as before. Indeed, EvoCycle still reaches a high quality of 94.7%. The NBC cartridges can only achieve 54.9%. Therefore, HP believes in its new product and sells EvoCycle cartridges at the same price as their "normal" cartridges. Additionally, the EvoCycle cartridge is designed and produced, so it can be sent to France again if it goes EOL again. It will be refurbished with the same process as before and sold as a new EvoCycle cartridge (For Elements Consulting, 2021).

Another core principle is the system perspective. It describes that economy does not need a gradual twisting but a fundamental system change.

It needs three steps to transform a linear into a circular economy:

1. The macrosystem: Is concerned about the industrial composition and structure of the entire economy and that it should adapt to a circular economy.
2. The mesosystem: This approach focuses on eco-industrial parks as systems, so it is on a regional level.
3. The microsystem: It concentrates on the products, individual companies, and what needs to happen to increase the company's circularity.

Aims

The core principles are defined with their two different approaches. Now the definition of the circular economy needs also aims. Nevertheless, three aims are based on sustainable development:

- Environmental quality
- Economic prosperity
- Social equity

These three aims must interact with each other without damaging one another. Additionally, they should not harm at the expense of future generations. For example, politicians should not incur national debts to protect the environment, damaging economic prosperity. However, these aims have different interests. Therefore, it is challenging to reconcile them. Although economic prosperity is the most important factor for society and economic prosperity mostly means that the environment quality is neglected, as seen in the linear economy model. Furthermore, social inequity can be discovered in most rich countries because regulations contribute to prosperity but do not support humans.

Enabler

Enablers are the so-called business models, which will be explained in the following bullet points of the thesis.

In the end, the authors Kirchherr, Reike, and Hekkert made the following definition for a circular economy, including the aspects above:

"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)

As explained before, a linear economy works like a river. Raw materials which are newly gained from the ground are constantly running into the system. On the contrary, a circular economy functions like a lake. Materials are already in the system and new ones do not enter. The quality and quantity of the materials remain the same as water in a lake (Eisenriegler, 2020).

The difference between linear and circular economy is explained by understanding how these two approaches work. The following bullet point shows how a circular economy can be implemented as a business model for companies.

4.2. Circular Business Models

Circularity is getting more crucial nowadays. Being sustainable is not seen as a problem anymore. It is an opportunity for companies. Enterprises should not just redesign their products but find a new product–service combination and a proper business model (Bocken et al., 2019).

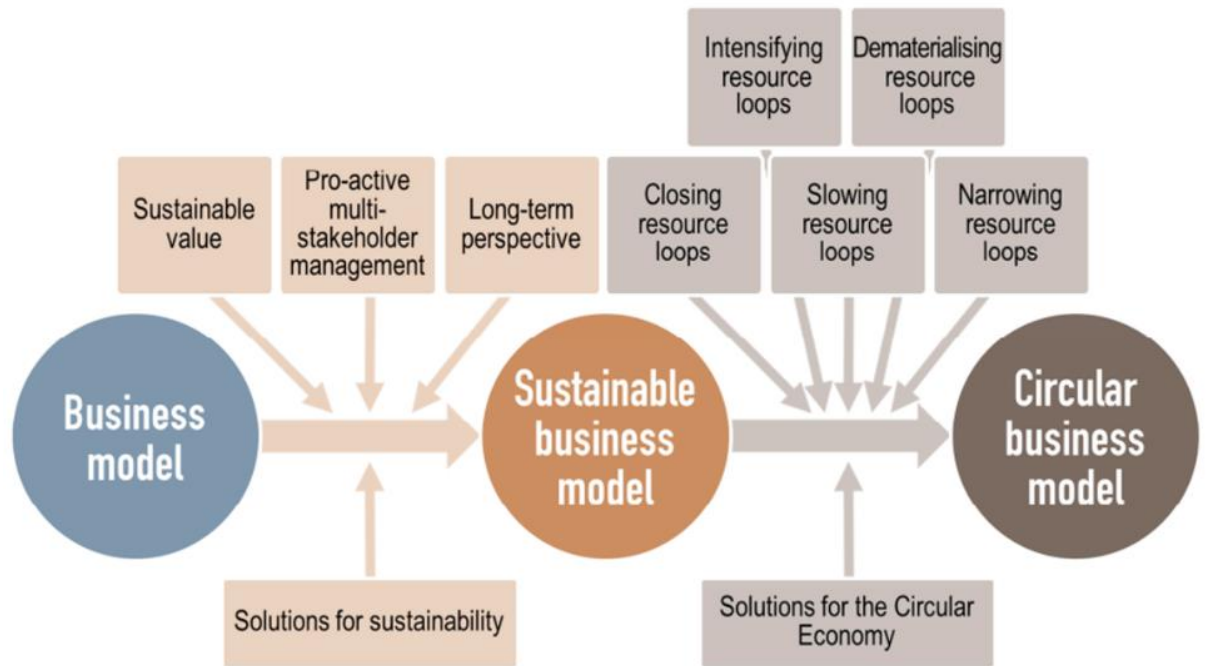


Fig. 8: Comparison of traditional, sustainable, and circular business models (Geissdoerfer et al., 2018)

The figure specifies how a traditional business model gets more sustainable and finally becomes a circular business model. This transformation occurs by finding solutions for being more sustainable, which is called sustainable development. That means that the companies need to achieve additional values. These values should be sustainable, the stakeholders should work pro-actively to reach them, and they should be planned long-term. Afterward, companies can think about solutions for a circular economy. This happens when the described loops of the above figure are closed. If a company reaches to close them, raw materials input and the waste outcome can be minimized (Geissdoerfer et al., 2018).

Nevertheless, business models are potential drivers to transforming a linear into a circular economy. They want to extend the product life cycles and their components, meaning that products will be used again, and the loops will be closed (Bocken et al., 2019). The loops are closed through repetitive cycles of reuse, repair, remanufacturing, and closing material loops (Nussholz, 2017). Therefore, a circular business model does not require external influences, like raw materials, to minimize waste. However, this model is still very theoretical, and few companies can apply it yet. Firstly, society, business, and policy must rethink to change and adapt appropriately.

Business models include a value proposition, value creation and delivery, and value capture. Nevertheless, the value should not just satisfy companies and their customers. It should bring value to the society and environment, too (Bocken et al., 2019). Unfortunately, as mentioned before, many companies, particularly small and medium-sized enterprises, did not apply circular business models because they could not create and capture additional values to build a product life cycle with circular resources. As a result, companies do not see an additional benefit for value creation and value proposition to reach the full potential of value creation (Nussholz, 2017).

4.2.1. Value proposition

Value proposition means that a company does not sell the product ownership but offers a product–service concept (Bocken et al., 2019). This indicates what value is offered and to whom concerns factors like the offer, customer segments, and customer relationship (Nussholz, 2017). However, the offer of a company – the product and service offering – reflects itself in the primary target and vision of the corporation. It should generate revenue to cover direct and indirect costs. Additionally, the product and service should be designed environmentally friendly to be reused. Finally, social well-being must be supported, and the concept needs to be planned from a long-term perspective (Geissdoerfer et al., 2018).

4.2.2. Value Creation and Delivery

Value creation and delivery represent how value is provided, like activities or the sales channel (Bocken et al., 2019). Therefore, knowing how the value is offered is essential, including key resources, key activities, key partners, and channels (Nussholz, 2017). A circular economy's aims - environmental quality, economic prosperity, and social equity - can only be reached if a value network is built through value creation and delivery. The stakeholders of this network must be willing to achieve these aims. Value creation and delivery is the most significant difference between a conventional business model and a circular one, especially in the supply chain (Geissdoerfer et al., 2018).

One example of value creation in a circular business model is the HP Managed Print Service Program. Therefore, the key activities must be chosen. In this case, this program can be compared with a leasing contract. Printers will not be sold but leased. So, the

customer has a long-term contract and remains loyal to HP. Afterward, the key resource must be found, which is the HP Planet Partner Program. In this program, HP's partners send the used hardware back to HP, which can reuse the materials. The partners are selected ones, and in Germany, for instance, HP has just around 100 MPS partners, which are their key partners. With the MPS partners, HP has developed a proper channel to sell their products and get the hardware back to close the loop.

4.2.3. Value Capture

Value capture implies how a company is earning its money or how they are capturing value in other forms involving the cost structure and revenue flows (Nussholz, 2017). Nevertheless, a company should achieve its economic targets and contribute to environmental quality and social equity in the short- and long-term (Geissdoerfer et al., 2018).

Value proposition e.g. Product Design	Value capture e.g. Incentive for return/repair/...	Value creation and delivery e.g. Supply chain	Example Office furniture	Economically sustainable e.g. Profit	Environmentally sustainable e.g. CO ₂ footprint	Socially sustainable e.g. Jobs created
L	L	L	Traditional office furniture manufacturer	=	=	=
L	L	C	Recycling of returned furniture	-	+	=
L	C	L	Discount for returning old furniture, disposal by retailer	-	=	=
L	C	C	Discount for returning old furniture, recycling of conventionally designed furniture by manufacturer	-	+	+
C	L	L	Product design that uses recycled materials purchased from third parties	=	=	+
C	L	C	Recycling of returned furniture, product design that makes use of recycled materials	+	+	=
C	C	L	Discount for returning furniture, disposal by retailer, third party recycled materials in product design	=	=	=
C	C	C	Discount for returning furniture, in-house recycling, product design that uses recycled materials	+	+	+

+ Positive influence
 = Little influence
 - Negative influence

Fig. 9 A value-based view on the sustainability of circular business models (Geissdoerfer et al., 2018)

The figure shows an example of an office furniture company and explains the difference when value proposition, value capture, and value creation and delivery are linear (L) and circular (C). Furthermore, it describes the before-mentioned aims for the economy, environment, and social society and how the values influence them. They can be affected positively, negatively, or hardly influenced. It can be recognized that the figure is getting more circular with every row, which positively influences the aims. For example, it is still a conventional business model in the first row, so the values are linear, and the aims are hardly influenced.

Contrary to the first row, the last one demonstrates that the company allows a discount for returning furniture, does in-house recycling, and designs its products to use recycled materials. Therefore, the values are all circular. That affects the aims positively, and the office furniture company can reach an optimal sustainability performance (Geissdoerfer et al., 2018).

Nevertheless, creating a resource efficiency strategy is crucial to achieving optimal sustainability performance. Preparing a resource efficiency strategy will be simplified if it is thought about how to create, deliver and capture value (Nussholz, 2017).

4.3. Difficulties in the implementation

As mentioned before, especially small and medium-sized enterprises (SMEs) must overcome many barriers to applying a circular economy in their company. In Europe, 99% of the companies fall in the category of small and medium-sized enterprises. That means that SMEs provide two-thirds of all workplaces in Europe. In the UK, they even made a study that 54.000 new employments can be generated by 2030, thanks to a circular economy. If SMEs would get more circular as well, this number could increase. Still, the difficulties of the implementation are too severe now (Rizos et al., 2016). In the European Union, politicians suggested legislative proposals for companies to become more circular. Hence, the EU got more competitive, and firms generated new business opportunities. As in the UK, the number of new workplaces rose and also social integration. Additionally, in the EU, they could save energy costs enormously, which preserves the environment, too (García-Quevedo et al., 2020).

The thesis has discussed that SMEs still do not see the future value of the circular economy, so they do not invest in the related costs. Moreover, there is a lack of knowledge on introducing a circular economy. Additionally, so-called market pull-and-push factors like innovations in technology or if the end customer is interested in sustainable products must be considered. That implies that many customers still prefer cheap products and do not care about their origin or composition, especially in the household sector, which produces the most waste.

Smaller companies have more difficulties implementing a circular economy than bigger ones because concerns often possess their research centers. That is why they also can lure new talents and discover new product designs. On the contrary, SMEs must mainly utilize technologies used by the current market. Supply chain managers should be aware of the present-day risks, and talented managers prefer to work for big enterprises. As a result, SMEs do not have the expertise to apply a circular economy.

In the following section, the thesis will explain the problems why applying a circular economy in SMEs in more detail:

Company environmental culture

This point corresponds to the vision and code of conduct of a company. These do not include a circular economy because the manager (often the company's owner) and the employees do not acknowledge it. Owners of SMEs are not responsible for the company privately, but mostly it is their only source of income. So, the decision-maker is often very risk-averse and does not want to choose a new business strategy. An outstanding, planned value proposition is necessary to change the company's approach and reach circularity in the end. However, it takes an extended period to achieve. Furthermore, some employees will counter such a new strategy because they think their workload will rise, so it is even more challenging to motivate them and reach a circular economy.

Lack of capital

The biggest challenge for SMEs to introduce a circular economy in their company is a lack of capital because it is necessary to plan more productive, which requires good management. Managing a reverse logistics network is crucial because introducing the model is time-consuming and cost-intensive. However, SMEs are susceptible to

additional cost factors that burden the business. Moreover, traditional managers or owners are still suspicious of the "product as a service" model, and they see it more as a challenge than an opportunity for their business.

Additionally, the circular business model needs to be monitored permanently, and the product life cycle should be improved, which demands more monetary, human, and material resources.

Another barrier is that SMEs do not often look for governmental support because of the lack of resources. That means they cannot afford to employ workers who only engage themselves to solve this problem. On the contrary, large enterprises usually have a legal department for such matters (Rizos et al., 2016).

Lack of government support / effective legalization

Many governments do not support the circular economy model enough, so companies are not motivated to transform their business model from linear to circular. For instance, there often does not exist a strict legislative framework. Moreover, the market offers cheap raw materials, so companies are not forced to use recycled materials. Additionally, they think recycled materials generate extra costs because they must be pre-processed (Rizos et al., 2016).

Rizos wrote this article in 2016, so the situation nowadays has changed. The prices of raw materials are increasing rapidly. Therefore, SMEs should reinvent themselves because the prices of raw materials could rise higher than the costs of using recycled materials. Nevertheless, this would influence the circular economy positively.

Another aspect of effective legalization is competition legalization. Circular business models could be advanced better if companies would collaborate. They could work together to develop circular business designs and a reverse infrastructure. Admittedly, sharing business information is seen as a threat because it could harm competitiveness. Even if companies within a value chain work together, legislative authorities often identify this as a punishable cartel in the European Union (Rizos et al., 2016).

Lack of information

Many SMEs do not even know the term circular economy. However, many companies do not recognize that they have taken the first steps toward a circular economy because they value recycling and reusing within their company. Nowadays, waste management is actually seen as a new business opportunity.

All value chain stakeholders must collaborate, so the transition to a circular economy can happen. The problem is that companies prefer to keep their confidential information to themselves, as mentioned before. As a result, the companies do not trust each other, so competitiveness is an issue for introducing a circular economy. Therefore, innovations cannot be adequately developed due to a lack of combined ideas within the value chain.

Administrative burden

Administrative challenges are the continuous monitoring and reporting of the company's processes. The data appears overly complex, and SMEs require additional skilled workers to overcome this barrier, which is also cost-intensive.

Lack of technical and technological know-how

A linear economy is still the traditional business model, so the company's technology is adapted to a linear model. The transition to a circular business model will change the daily processes. However, the production processes can only be readjusted with appropriate investments and training for the employees. It will be problematic to create new product designs that are more sustainable and can be reused or even upcycled without these investments.

Additionally, SMEs depend on their suppliers and to what extent their technical advances support the circular economy. As indicated before, raw materials are still cheaper than recycled ones, so suppliers prefer raw materials.

Lack of support from the supply and demand network

This part describes how the lack of interest from suppliers and customers of SMEs in sustainability and green products can lead to a barrier in the transformation.

Suppliers' sites can induce a problem because they suspect losing their competitive advantage if they are included in a mutual circle within the value chain. Moreover, some

suppliers did not include a circular economy in their vision. The value chain would generally be rearranged as more complex – its products, processes, and services. Not all suppliers agree to take these risks, but SMEs depend on their suppliers to become more circular.

There is mostly a lack of interest and information about more sustainable products on the customer site. They are purchasing their accustomed products because they have no severe reasons to change them. That means that the customer's lifestyle must be altered. Furthermore, sustainable products are usually more expensive, so customers keep buying cheaper alternatives because they cannot see any additional value in purchasing the pricy ones. Additionally, the model "product as a service" is not assumptive in the private sector because end customers want to own the product as a status symbol (Rizos et al., 2016).

Especially SMEs which would like to become more circular are facing these challenges because end customers do not identify themselves with such small companies. Therefore, they would purchase a cheaper alternative product instead of the more expensive but circular one.

To cut a long story short, SMEs know that more circularity would lead to an advanced business, but they need to overcome the named barriers. Their main reasons for reaching a circular economy are savings of material costs, competitive advantage, or entering a new market segment (Rizos et al., 2016). Therefore, companies that really want to introduce a circular economy try to create new innovative product designs that require less or no raw materials at all. That is the primary way to overcome the barriers named above. On the contrary, if enterprises only attempt to reduce waste or energy costs, they can only avoid administrative burdens and regulations (García-Quevedo et al., 2020).

5. Reverse Logistics

5.1. Principles of Reverse Logistics

Over the years, supply chains got to work pretty well – from the winning of raw materials until the sale to the end customer (de Brito & Dekker, 2004). However, due to climate change, companies and their supply chains are forced to invent, try out, use, and improve new sustainable approaches. Hence, their carbon footprint will be minimized. Therefore, recycling and reusing are increasingly important nowadays (Alshamsi & Diabat, 2015). Furthermore, governments try to decrease companies' emissions through different concepts and regulations (European Parliament, 2021).

That is why companies need to rethink their supply chain and not just value their forward supply chain but also their reverse supply chain. Nonetheless, reverse logistics only got attention from the economy and society in the last couple of years because of altering the environment, economy, and social society (Alshamsi & Diabat, 2015).

Reverse Logistics was already mentioned in literature in the seventies but only concerning recycling. In the 90s, literature tried to find a definition for the term reverse logistics for the first time, which applied more to waste management. Nevertheless, reverse logistics cannot be compared to waste management because it would mean that it just concentrates on collecting and processing waste. The products would not be reused newly. Reverse logistics also does not equal green logistics since it focuses not only on environmentally friendly activities in the value chain. Green logistics concentrates more on forward logistics (de Brito & Dekker, 2004).

However, Alshamsi defined reverse logistics as follows in 2015:

"Reverse Logistics refers to the series of operations that initiate at the consumer level with the collection of products and terminate with the reprocessing of these products at remanufacturing facilities." (Alshamsi & Diabat, 2015)

Consequently, it can be said that reverse logistics is part of sustainable development. That means that companies want to motivate society to give back their old or broken products to be reused effectively and efficiently, and the value can be used for a new

product (de Brito & Dekker, 2004). It is also linked to social sustainability, which is also gaining attention in society. It is not even necessary to motivate consumers that much because they are willing to recycle more. The more crucial problem is how easy or difficult it is to recycle or reuse products which depends on the different sectors. Some industries need sorting machines that know how to disassemble a product, like separating a shoe sole and shoelaces. Other industries require chemical processes so that they can reuse the material again. For example, in the cosmetic sector, they need to remove the make-up remains from the package (Sarkis et al., 2010).

Nevertheless, society and the environment are pressuring companies to work on a solution, so they must implement a backflow of their end-of-life products. The other reason is that concerns are losing millions of dollars without proper management of this backflow. That is why reverse logistics is essential for every aspect of the supply chain and a key competence for companies nowadays (de Brito & Dekker, 2004). Thanks to an excellent reverse logistic process, materials in the forward logistic can be reduced. Forward logistics means the process from gaining the raw materials to selling them to the end-user. Therefore, the process can be compared to the linear economy, as it was explained in figure 5. The circular economy loop can be created and closed through a reverse logistic process, so the end customer brings the product back, and it will be recovered to be sold to a new end-user (Sarkis et al., 2010).

However, why do supply chain actors want to return their products, so reverse logistics is required?

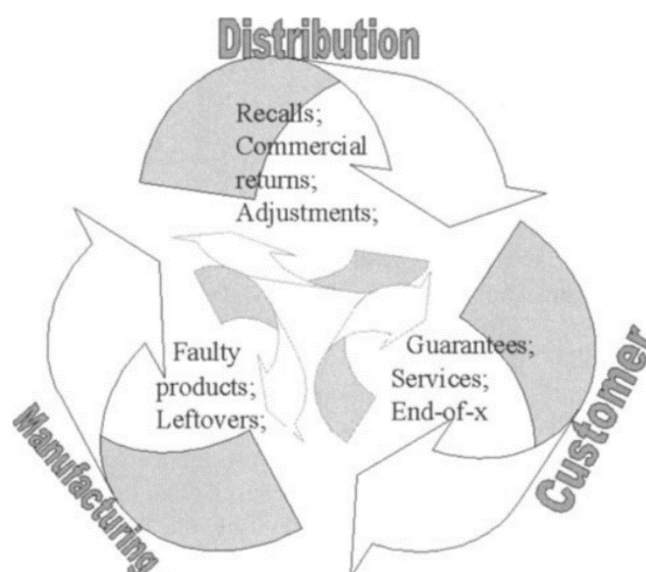


Fig. 10: Return reasons for reverse logistics (de Brito & Dekker, 2004)

The main reasons, therefore, are that the product does not perform properly or is not required anymore. As described in the figure above, it needs to be differentiated between manufacturing returns, distribution returns, and customer returns.

Manufacturing returns mean the materials created during the production phase will be returned. For example, raw materials are leftover or generated byproducts during the production that are not used for the actual product as mentioned in the second bullet point. Furthermore, waste is also generated during production that could be utilized for other purposes.

Distribution returns imply the products which are sent back during the distribution phase. For instance, that includes product recalls because the product could harm the safety or health of the user or products whose expiration date is reached, like food or medicine.

Customer returns indicate that products are given back from the end customer. Usually, the B2C commercial channel is used for this kind of return. The most common example is unfitting clothes after the try-on at home. Another example is the warranty return. That describes that a product broke down during the warranty period, and there are contracts between customer and company that it can be returned, or must be repaired, or replaced by the company (de Brito & Dekker, 2004).

The reverse logistics process not just responds to recovery. The whole process is much more complex. The figure below explains the reverse logistic process.

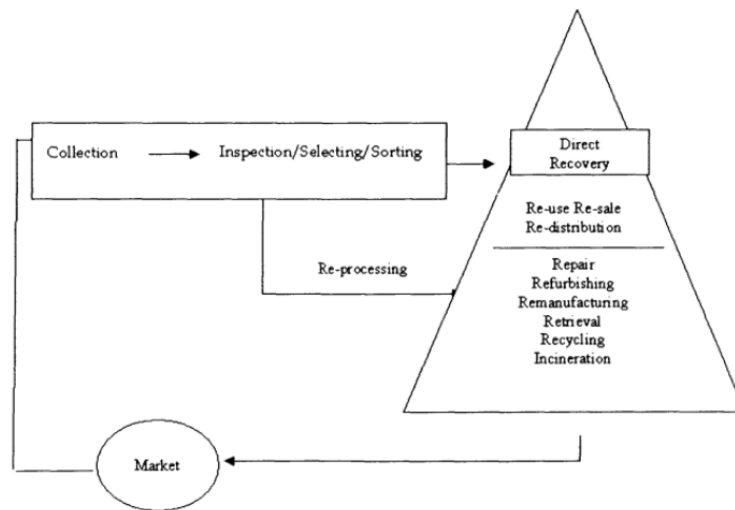


Fig. 11: Reverse logistics processes (de Brito & Dekker, 2004)

Reverse logistics starts with the collection of the products. That means that products that are not used anymore will be brought from end consumers to a point of collection. These products will be passed to the inspection, and they will be examined there. Next, the company decides how the product will be recovered in the selection process. Then, it will sort the product accordingly. After finishing this three-part process, the enterprise will transfer the materials to the actual recovery process. Here it is distinguished between direct recovery and processing recovery. It depends on the quality of the product if it can be transformed through the direct recovery process. So, it would be reused, re-sold, or redistributed and directly brought back to the market because it is like new.

Nevertheless, if the quality of the product has decreased too much, it will be passed to the processing recovery. Here different levels can be found, which are based on how much effort is needed to recover the product:

- Repair
- Refurbishing
- Remanufacturing
- Retrieval
- Recycling
- Incineration

The Evocycle toners from HP describe the remanufacturing process, to mention the previous example. This process operates as a component recovery which implies that the toners will be reprocessed, and new components like, in this case, a new imaging unit will be inserted. That shows that the HP Evocycle toners are an established reverse logistics process.

If products or materials cannot be recovered, they will become waste and be brought to the landfill (de Brito & Dekker, 2004).

At some point, every product reaches the circumstance of being an end-of-life product. Therefore, companies are creating product life cycles to calculate the related costs for every product. Furthermore, innovative enterprises are planning at the beginning of designing a product proper reverse logistics activities.

5.2. Opportunities

The government's regulations force some companies to take back their end-of-life products. However, on the other hand, some enterprises see it as an opportunity to retract their products and the value of reusing them.

The below figure shows three reasons why companies want to introduce a reverse logistics:

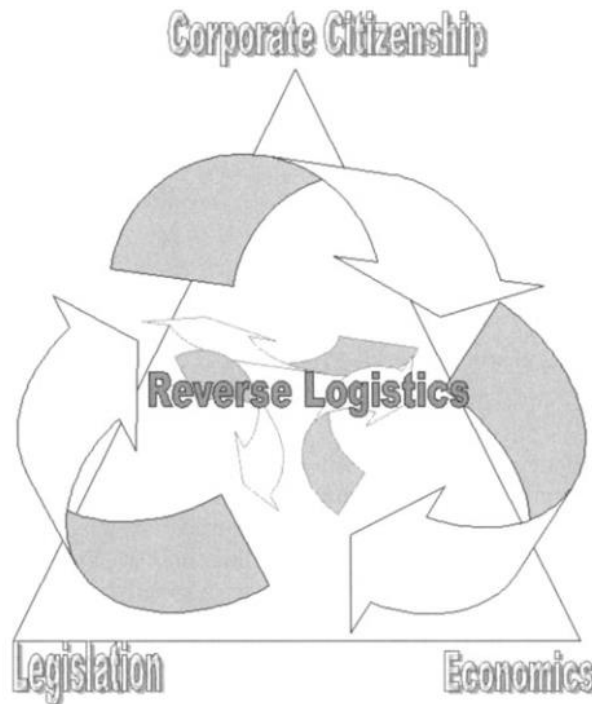


Fig. 12: Driving triangle for reverse logistics (de Brito & Dekker, 2004)

Economics

Firms are introducing reverse logistics because of the direct benefits of minimizing the use of raw materials, the value of product recovery, and the dwindling disposal costs. Generally, the remanufacturing of used products generates financial benefits for a company. One example can be found in the electro industry. Media Markt in Germany has assembled machines to take back old smartphones. These machines analyze the value of the smartphone and prepare a buying offer for the customer in a few minutes. If the customer accepts it, he/she gets a voucher to buy something else in Media Markt. In addition, the company incurs waste disposal for the customer. Of course, the smartphones will be recycled properly, and the materials reused or recovered for new products.

Another opportunity is the aspect of marketing. Companies are receiving indirect benefits because they are more sustainable than others, which is a principal factor nowadays. End customers are more aware of the environment; therefore reverse logistics is a competitive advantage for enterprises. So, they gain a green image. Additionally, a company can protect their innovative technology better if they are recovering their old products by themselves. If a third party that does not have a contract with the company

takes care of the products, they could steal the technology. In addition, recovery strengthens customer or supplier relations (de Brito & Dekker, 2004).

Legislation

Nowadays, many laws and regulations in Europe correspond to the right of return, recycling, and minimizing packages or waste. If a company introduces reverse logistics at the beginning of the product cycle, regulations can be counteracted. Therefore, they do not provoke unplanned cost factors in the future (de Brito & Dekker, 2004).

Corporate Citizenship

This point describes the values or principles of an enterprise. So, deep reverse logistics is anchored in their code of conduct, meaning that coordinated reverse logistics is also an opportunity to achieve social and environmental responsibilities (de Brito & Dekker, 2004).

These three factors cannot be seen separately because they do not have fixed boundaries. For example, the company must give the end customer a right of return, which is mandatory in many countries. However, companies also see it as an opportunity to attract more customers and thus increase the benefit of the company and its reputation (de Brito & Dekker, 2004).

However, companies must create remanufacturing strategies nowadays. One possible strategy is the closure of contracts with customers, which means that the company takes back the products after a specific use time. So, the company gets back these products more manageable and can recover them to generate new products for the market. This strategy has economic and ecological advantages because the customer commits himself to the company for a long time. Therefore, the reverse logistics process is smoother. Additionally, the company can plan better for the future when older products are coming back to them and when they are available to reuse the materials for the new products or remanufacture them.

Regarding the author, 85 % of energy costs can be saved if a product is remanufactured instead of producing a new one. In general, it can be said that remanufacturing has essential benefits:

- Saving resources
- Compensation for used energy
- Reduction of waste generation

The company's revenue is decreasing when selling remanufactured products because consumers still think these products have worse quality than those from raw materials. Nevertheless, overall, the percentage of sales is higher, so the profit is increasing as well. Therefore, marketing and sales strategies must be adapted accordingly (Kumar & Putnam, 2008).

Moreover, good supply chain management is essential. At the beginning of the supply chain, a product's design must be thoughtful. The decision-making process about the product's design must happen before producing it. Furthermore, there are regulations that products must be designed to minimize waste, and harmful substances must be eliminated. However, product redesigning has the advantage of sinking manufacturing and lifecycle costs. That means that products that are simpler to recycle or remanufacture can be brought back to the market faster (Rubio & Jiménez-Parra, 2014a). Therefore, a circular supply chain can be created after a period, which will be explained in more detail in the next bullet point.

5.3. Challenges

Reverse logistics does not only contain many opportunities but also challenges and barriers which companies must overcome. Accordingly, many open questions need to be answered before introducing reverse logistics. For example, a high risk exists in the design phase of reverse production because transportation, possible facility locations, and other factors are causing higher costs. Therefore, supply chain management must be well coordinated to avoid unnecessary costs. So there are many different questions like:

- How exactly should the transport routes be designed?

- Where exactly are the best locations for facilities such as remanufacturing or recycling plants and inspection centers?
- Should the aspect of transport be outsourced?

Outsourcing has become a handy tool nowadays because it has many advantages. For instance, expanding the transportation system through a third party saves costs, making it easier to enter a new market or region, labor cost savings, and asset reduction. On the other hand, the company has to deal with the loss of management control and disruption of company unity (Alshamsi & Diabat, 2015).

Ultimately, the enterprise decides which is the most suitable return channel. In this connection, the cost of recovery should be revised. Outsourcing helps reduce transport costs by offering collection points so end customers can give back their end-of-life/end-of-use products. Consequently, the third party should value the delivered components and process them accordingly to bring them back to manufacturing. If the cost of recovery is lower than the cost of transportation, the company should manage the return channel by themselves.

Nevertheless, most companies prefer to outsource some reverse logistics activities because it is more complicated to handle than the forward supply chain. Firms need sufficient knowledge and specialization to control their reverse supply chain (Kumar & Putnam, 2008). The problem is that this is a crucial barrier, and very often, there is a lack of workforce to manage it properly. Their reverse logistics technology is often not fully developed, and sorting processes are made manually. This process is labor-consuming, or there is no experience with toxic waste (Sarkis et al., 2010). So, companies decide to outsource it. The third company reacts faster to different challenges because the employees are trained for special situations. The following services are often outsourced (Kumar & Putnam, 2008):

- Call Centers
- Field swaps
- Parts repair
- Screen for refurbishment/remanufacturing

Another barrier besides the return channel is a lack of knowledge regarding the end customer. End users often think that recycled or remanufactured products have worse quality than new products made of raw materials. This is because they could not collect enough experience with these products yet. One solution would be to create a new brand showing remanufactured products' advantages. Therefore, companies can appeal to end customers to think about their social sustainability like they do and promote their remanufactured products. The most important part is to explain to the end-users that there are hardly any differences in the quality of remanufactured products and that they can trust them as well as they do with new products (Hamzaoui-Essoussi & Linton, 2014).

In the example above about the Evocycle toners, HP is trying to overcome this barrier in this way. The toners are remanufactured, and the quality remains almost the same as newly produced toners. Therefore, they are offering the same price for both toners.

Another challenge is the coordination of the supply chain and reverse logistics. Once a company offers new and remanufactured products, the production lines need to be adapted. The best lot sizes and production sequences must keep the supply chain in order if product types are produced on the same line. Therefore, investing in a new production line to produce the two types separately would be better. However, not all companies can afford this, although it saves costs. The following parties are included in a well-coordinated supply chain with integrated reverse logistics processes (Rubio & Jiménez-Parra, 2014b):

- Multiple suppliers
- One manufacturer
- Multiple distributors
- Multiple retailers
- One third party

The third-party is responsible for collecting the end-of-use products from end customers to bring them to the inspection department.

It could be challenging to satisfy all the parties in this supply chain, so it is recommended to negotiate a revenue-sharing contract. Therefore, all interested parties have an advantage of this arrangement (Rubio & Jiménez-Parra, 2014b).

The mentioned bullet points explain why sustainability is crucial and why present-day society can no longer hold on to the linear economy. Therefore, companies must transform into a circular economy to solve this problem. The first few steps were already made in the right direction through integrating reverse logistics. To close the loop, they use end-of-use products to produce new, remanufactured products. However, much waste is caused by the supply chain of companies. All these aspects need to be summarized to work on a circular supply chain which will be described in the next bullet point.

6. Circular Supply Chain Economy

6.1. Definition

First, it is crucial to define the concept of circular supply chain management. The previous aspects of this thesis tried to point out how important it is to integrate circular supply chain management. The planet's raw materials are getting rarer, so humans must learn how to handle resources more efficiently and reuse them. The author Bressanelli organized a Life Cycle Assessment and identified that using remanufactured products could decrease 60% of carbon dioxides. In Europe, scientists suppose companies could earn 2.15 billion euros when implementing well-coordinated reverse logistics in the electronic industry by collecting the electronic waste, recycling, and recovering it (Bressanelli et al., 2019).

However, a circular supply chain implies the circular economy model within supply chain management. It shows a new opportunity for a sustainable supply chain.

Nowadays, the literature on circular supply chain management is still dim because it is a new concept and cannot be compared with other sustainable supply chain approaches. It is necessary to research further to apply the concept in practice. That is crucial because consumption, global patterns of production, and trade are still harming the environment severely. The introduction of circularity in the supply chain only has advantages for the sustainability concept of a company. Therefore, literature has many theories about environmental supply chains, sustainable supply chains, green supply chains, and closed-loop supply chains. The problem is that introducing these concepts transforms companies into more sustainable ones, but it cannot be compared with an integrated circular economy in supply chain management.

Critical principles of circular economy can be found in a supply chain on a strategic level, in the design, or product production. Nevertheless, it can never be identified in the whole supply chain.

The definition of a circular supply chain management must include the following two concepts (Farooque et al., 2019):

1. Processes are necessary, whereby products are recovered, reused, or remanufactured. So, they come back to the market as new ones. Therefore, circular thinking is essential.
2. A company's vision must integrate the circular economy philosophy and a zero-waste economy.

There is still a lack of knowledge on both sites, companies, and consumers. Therefore, it is impossible to introduce a complete circular supply chain. The authors Farooque, Zhang, Thurer, Qu, and Huisingh, propose the following definition of circular supply chain management to overcome this gap:

"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 stakeholder in a product/service lifecycle including parts/product manufacturers, service providers, consumers, and users." (Farooque et al., 2019)

If a sophisticated definition exists in literature, the possibility of finding a practical model will rise. Companies must learn to collaborate with others inside and outside the sector. Therefore, they can maximize the utility of the materials and products. The advantages are that resources are used efficiently, and consequently, the profit will increase, and the negative consequences for the environment, society, and economy will decrease drastically.

Nevertheless, there are three supply chain configurations outlined when introducing a circular economy in the supply chain management (Farooque et al., 2019):

- Eco-industrial parks which are on the meso level
- Environmental, sustainable, and green systems
- Closed-loop supply chains

Nowadays, companies have integrated some circular economy activities, like product design, at least on the micro-level. However, a significant transformation of business models and the supply chain is required to introduce a circular economy.

As mentioned before, there are essential aspects to transforming a company's supply chain more circular:

- Try to keep the value of the products using proper designs
- Introduction of circular business models; companies keep the product ownership
- Integration of reverse logistics in the supply chain to recover used products
- Support for introducing a circular economy like collaboration or digital technologies

Present-day, a circular supply chain is still relatively rare because it is a very theoretical approach. However, companies have recognized the opportunity for higher revenue. Nonetheless, hardly any companies redesigned their supply chain in a circular one. It is impossible for a single actor in the supply chain in the vertical integration to control the production, distribution, and consumption process (Bressanelli et al., 2019).

Practically any company implements all four abovementioned points to introduce a circular supply chain. One example of HP shows that it tried to implement all the mentioned aspects.

An example is HP's Instant Ink model. A private person purchases a printer and can conclude a contract with HP to receive new ink periodically. The end customer pays the corresponding price depending on how many pages are printed. If a cartridge is almost empty, a new one will be delivered. Therefore, fewer cartridges will be transported, which saves CO2 emissions.

Additionally, this approach reduces packaging material. When HP supplies a new toner, it contains a box to send back the old cartridge. HP cartridges are made from 100% recycled materials. 85% of this material is retrieved from used HP cartridges that end customers returned.

That is one rare example that works because just one actor is responsible for the design and manufacturing, so it is easier to introduce a circular supply chain. For instance, integrating circular supply chain management in SMEs is more complex, and they are the motor of the economy (Bressanelli et al., 2019).

6.2. Introducing circular economy in the supply chain

However, it is essential to identify how a circular economy can be introduced in the different supply chain activities (Farooque et al., 2019):

Product / Services Design

As described repeatedly in the thesis, the design of the product and services must change drastically. Especially the product/service design has a crucial influence on the value chain and, therefore, on the circular economy. Additionally, the packaging and labeling of the products affect the company's circularity. The packaging must be designed more sustainably, and the labeling should attract the end customer directly. Therefore, companies must rethink their products and services, adopting all aspects of a circular economy.

Recently, a new circular economy strategy regarding the product/service design was developed, introducing a design for dismantling. This design is implemented in increasingly industrial sectors because this new technological innovation saves costs.

Moreover, this technology improves the efficient separation of materials and components to recover them. In addition, it explains how to manage a product at its end of life usefully. For example, it reduces the use of chemical separation processes when separating polymers in vehicle dashboards. A new mechanical approach will decrease the incompatible polymers. (Tian & Chen, 2014).

Procurement

A circular economy would influence prices, quality, time, and value for money. Nowadays, there does not exist much literature about circular economy within procurement. Therefore, companies must rethink how to reduce the purchasing of raw materials. Furthermore, a framework is necessary which describes how resources can be used better through recovery and consequently minimize waste. It is recommended to supply industrial products to reuse their material for new ones.

Economists are researching if applying a circular economy in supply chain procurement could counteract supply disruptions.

Production

Present-day, sustainability is particularly crucial in production to stay competitive. The reason is that today's consumers are attracted when they know that a product is produced sustainably because they want to prevent negative consequences for the environment. Therefore, green manufacturing is part of sustainable development. That has many advantages like cost savings in the long-term, reputation improvement, compulsory regulations alignment, and investors' attraction. However, in literature, they do not write just about green manufacturing but also about cleaner production, which tries to minimize waste and emissions. Cleaner production aims to act economically efficiently and decrease contamination and hazard for humans and the environment at the same time. If a company accomplishes implementing a cleaner production, it is already a step closer to becoming circular. Therefore, cleaner production is crucial for introducing a micro-level circular economy. Additionally, the following aspects of consumption, EoL, and waste management are influenced positively.

Logistics

Legal regulations and the pressure of society are forcing companies to rethink their logistics strategy. They expect more sustainable logistics, but companies must work cost-effectively simultaneously to keep their competitiveness. Therefore, the implementation of green logistics in companies is increasing. As a result, products are produced and distributed sustainably to reduce waste and energy or calculate the consequences of different distribution strategies for the environment. For a long time, companies have only concentrated on forward logistics – transport, warehouse, and inventory management from suppliers to customers. However, now it shows that reverse logistics is necessary for sustainable development. Therefore, the integration of reverse logistics is essential to achieve the transformation to a circular economy in logistics.

Consumption

Consumers must also rethink, so consumption can become more circular because resources can be reused, generating less waste. Therefore, circular consumption is getting more attention nowadays. One example is the mobile phone market. Mobile phones need a lot of rare raw materials for their production which could be reused from old mobile phones. Nevertheless, the problem is that the companies depend on the consumers' cooperation. Many times, they do not give back their old phones or do not accept refurbished ones. As mentioned before, consumers must change their behavior. Accordingly, one idea is to counteract the lack of information, so consumers do not see refurbished or remanufactured products as second-class products. Although there are cultural differences because, in developed countries, consumers purchase these products hardly, and in Third-World Countries, it is customary to buy them due to a shortage of money. To cut a long story short, introducing circular consumption requires much education from companies and governments.

EoL and Waste Management

Especially EoL and waste management are essential for circular supply chain management. They ensure that a product will be recovered and uses the remaining value. However, there is still a lack of knowledge of how these aspects can be adopted ultimately. There are the following different concepts:

Repurposing means a product is used differently because it can not be utilized as before. For instance, old laptops can be repurposed as thin computers without additional costs.

Refurbishing describes a used product whose functionalities are restored without dismantling it. As a result, the product's value is recovered to decrease waste. Nevertheless, the challenge is that society often does not accept this process because of quality issues and production variations.

Remanufacturing was explained in the thesis before. The product is reprocessed, and just some components are replaced. So, the utility of the product remains the same. Furthermore, the advantages are better quality than other processes. It expands the product life cycle and more environmental-friendly. However, customers do not fully accept this approach like the other ones. Therefore, the full potential of a circular supply chain is getting lost.

Recycling can help to transform towards a circular supply chain in some sectors. Mainly, the steel industry uses this process because the material is quite simple to recycle. That means that steel scrap can be recovered quickly which is required for steelmaking.

Nevertheless, EoL and waste management confront challenges because end-of-life products must be collected first to recover. For this purpose, the collection processes need to be adapted and improved to avoid product damage. For example, electronic devices are easy to wreck but they contain crucial recovery resources. Therefore, recovering most electronic waste would positively impact the environment and economy.

6.3. Barriers of circular supply chain mangement

Introducing a circular supply chain relates to many complex challenges to overcome. Therefore, this model is hardly applied in companies. The return flow is problematic to foresee, so companies cannot precisely determine the volume, mix, quality time, and place of the return. Consequently, production problems can appear if a company wants to reuse the old products. This dilemma cannot even be solved with a proper product design because it depends on the cooperation of the end customers.

One solution could be a contract between the company and end-user to prearrange the timing of returns, though companies cannot foresee the quality of the returns. As a result, they could be damaged, and it would need much effort to recover them. Nevertheless, contracts are not the perfect solution and would be too time-consuming and cost-intensive in the B2C channel. Additionally, not all end customers trust this business model because they would lose product ownership and control.

Another barrier to the circular supply chain is that the transportation costs could increase because the products must be collected from return points. Then they are sent to facilities where they will be recovered. After that, they will be brought to new distributions to return to the market. Here it is tricky to find proper supply chain partners with the knowledge and willingness to introduce a circular economy in their company.

Information sharing and coordination are essential if an enterprise finds a suitable partner, but many companies are worried about losing their competitive advantage. On the other hand, another challenge is to get a fitting IT system because all supply chain actors must plan together and require appropriate hardware and software. So, all necessary information can be stored and shared between the parties. One example is product traceability which all actors need to plan, collect, and recover products efficiently.

Nevertheless, it is crucial to transform a traditional linear supply chain into a circular one. Therefore, business models should be renewed to establish a circular supply chain through value creation. For this reason, the following point explains that the power of inner circle, the power of circling longer, the power of cascades, and the power of pure inputs are required.

6.4. Important characteristics

Firstly, summing up the previous bullet point, a circular supply chain should contain the following aspects (Yang et al., 2018):

1. Applying inner loops like reuse before the outer circles like recycling

2. Expanding the loops as long as possible so the resources are used further
3. Avoiding waste, byproducts should be utilized for other products

These concepts can be implemented through value creation, resulting from materials' efficient and productive reuse. This process is expressed through the power of inner circle, the power of circling longer, the power of cascades, and the power of pure inputs (de Angelis et al., 2018). The figure below describes these principles.

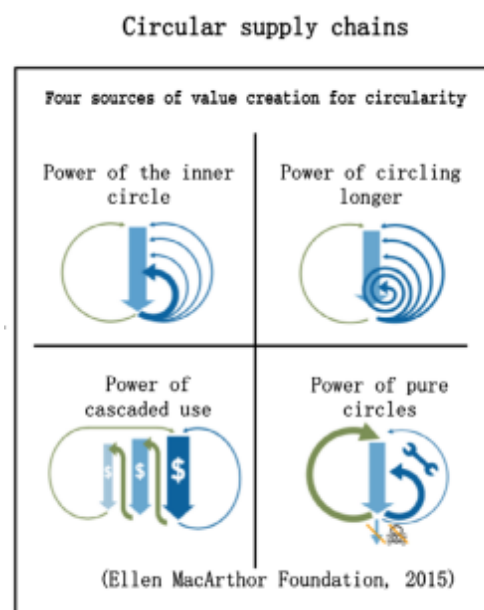


Fig. 13: Four sources of value creation for circularity (Yang et al., 2018)

6.4.1. The power of inner circle

The power of inner circle outlines approaches to how end-of-life products generate more economical and environmental value due to keeping more of a product containing materials, labor, and energy. These approaches should pursue the following four aims (de Angelis et al., 2018):

- Product life cycle should be expanded
- Products should be reused with only a few or no adjustments
- If refurbishment or remanufacturing is necessary, just a few components should be substituted, or new manufacturing processes recover used components

- Recycling means recovering materials with the same or another purpose

Indeed, recycling is the last alternative to seek because, during recycling, it often happens that the product and its materials will get a worse quality than before. So, the value will get lost.

The targets mentioned earlier can be seen as a hierarchy in which the first point represents the most valuable option. Regarding the authors De Angelis, Howard, and Miemczyk, the power of inner circle says that "tighter loops, those closest to the original product serve best value ... while outer loops ... provide less value" (de Angelis et al., 2018).

The figure below shows that as well. Repair, implicating to expand the product life cycle, is the innermost circle. This circle generates the most value. On the other hand, the outermost circle - recycling – loses the most value. These loops depend on the behavior of the end consumers. That means how they take care of their products and what they do with them when they reach the end-of-use phase. Companies must accomplish that their supply chain is expansive, so end customers know it, and return the products into the value chain. That is the only possibility to reach the full potential of the power of inner circle (de Angelis et al., 2018).

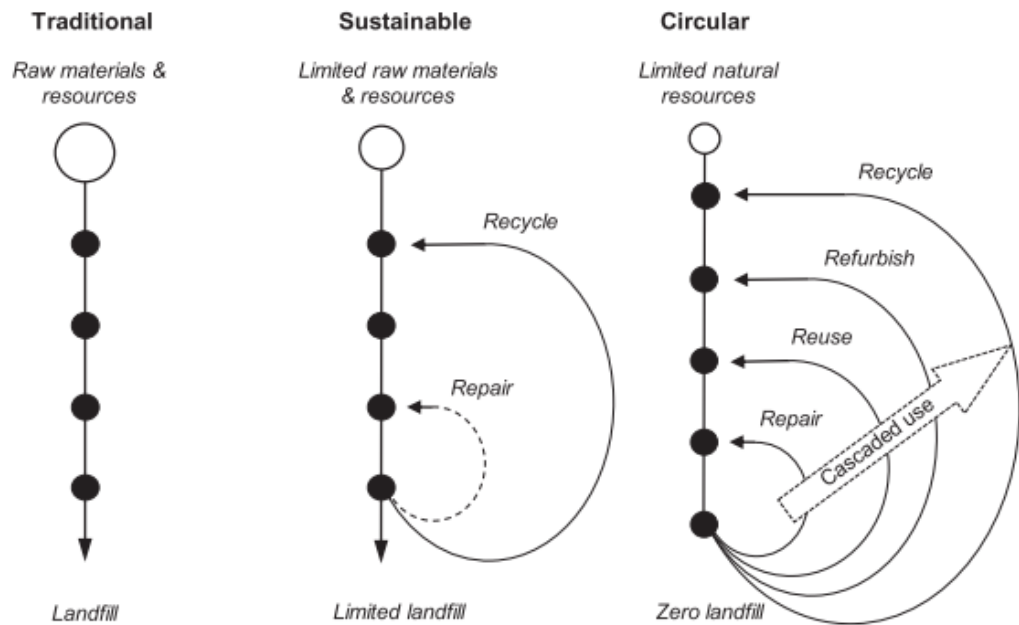


Fig. 14: Traditional, sustainable and circular supply chains (de Angelis et al., 2018)

6.4.2. The power of circling longer

Figure 14 describes the power of inner circle and the power of circling longer because circling longer is essential to developing a linear to a sustainable to a circular supply chain. So, the power of circling longer defines how much longer materials of a product can be continued to use. The company manages to expand the product life cycle and the four cycles – repair, reuse, refurbish, and recycle.

The power of inner circle and the power of circling longer can be implemented for durable products like smartphones. New or other devices can reuse their components or materials. On the other hand, these strategies cannot be applied to consumable products because they are normally used within a year, like food. Nevertheless, these products are mainly produced from natural resources, so they will not harm the environment and can be thrown into landfills. Textiles are also consumable products, but nowadays, the sector tries to implement the above-explained cycles, so the used materials stay in the loop (de Angelis et al., 2018).

6.4.3. The power of cascades

The power of inner circle and the power of circling longer generate opportunities for value creation by reusing the materials in the same supply chain within the four cycles. The power of cascades uses another approach. That value is generated and secured through the circulation of materials between different supply chains. This approach would fit consumable products (de Angelis et al., 2018).

For example, wood is cut down in the forestry sector, and companies produce veneer wood products. After reaching their end-of-use period, the veneer wood becomes particle-based products and then fiber-based products. Subsequently, the material is used as bio-based chemical products, and finally, companies utilize it as energy for electricity and heat. The figure below shows that the solid wood has the highest quality and that the quality decreases when reusing wood. Therefore, the direct energy generation after cutting down the trees is not desired. Instead, the wood should firstly be used within the supply chain for other purposes (Campbell-Johnston et al., 2020).

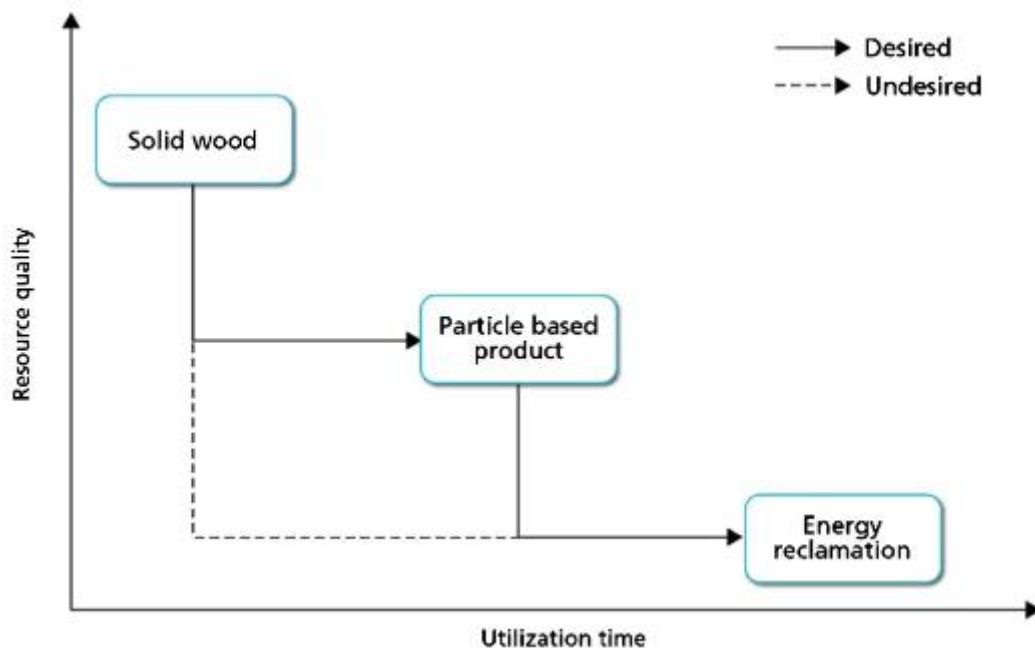


Fig. 15: Basic cascading example (Campbell-Johnston et al., 2020)

The circular economy recommends the power of cascades, which involves horizontal collaboration. That could lead to difficulties because the actors of different supply chains are competitors. As mentioned before, companies are unwilling to share their knowledge

about their technologies or processes. However, to implement a circular supply chain, collaboration is indispensable.

A company must see the gain of value in reducing waste and that shorter circles increase the value of materials use and productivity. An improved and cooperative customer and supplier relationship supports extending a product life cycle because the products are more straightforward to collect and returned. Therefore, the loops of repair, reuse, refurbish and recycle are using the power of cascades. This concept can only succeed if all supply chain parties receive specific incentives to give the products back, remanufacture them finally, and improve the quality of the used products (de Angelis et al., 2018).

6.4.4. The power of pure inputs

Before the power of inner circle, the power of circling longer, and the power of cascades can generate value, the propositions of the power of pure inputs must be applied first. The power of pure input means that material in the supply chain flow should remain uncontaminated. Therefore, it is easier to process the material, increasing productivity (Yang et al., 2018).

Circular economy recognizes that technical and biological loops are adapted when planning the product design. Additionally, the composition and after-use collection must keep the purity and quality of materials. For instance, in the plastic industry, 95% of plastic packages are not returned to the supply chain circle because the coordination is not aligned. The reason is that plastic is produced faster than after-use sorting and separation systems can handle nowadays. Therefore, a better application of the power of inputs in the product design is required in the future. One solution would be a standard composition and after-use treatment for plastic packages (de Angelis et al., 2018).

6.5. Four archetypes based on the concept of geography

Firstly, systematic leakages of material and product flows must be closed before introducing a circular supply chain worldwide. Furthermore, society is constantly growing, and resources become tighter, so a homogenous global economy is necessary.

A circular economy has the potential to counteract these problems, but there are still inevitable market failures and a lack of mechanics.

The most tangible option for supply chain managers to thwart these leakages is on a geographical level. That means the managers must think exactly about where to build their manufacturing facilities and contract suppliers so it fits into a circular economy concept. For instance, in the figure below, a simplified bill of materials for a power drill can be seen (WEF, 2014):

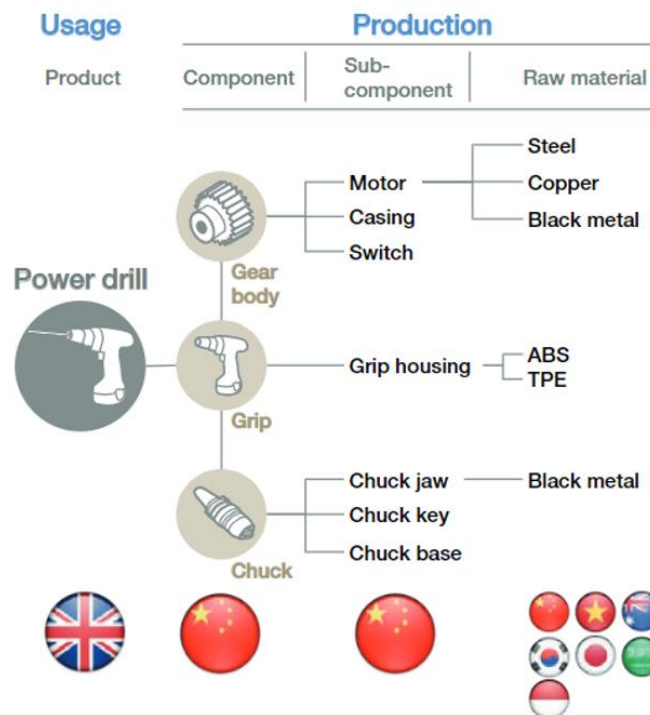


Fig. 16: Simplified bill of materials of a power drill (WEF, 2014)

The figure shows that raw materials – steel, copper, black metal, ABS, TPE, and black metal – are purchased from China, Vietnam, Australia, South Korea, Japan, Saudi Arabian, and Indonesia. Then the sub-components are produced in China and are brought to another manufacturing site in China to assimilate the gear body, grip, and chuck. So, the power drill is finished to use. Finally, the end product is sent to Great Britain, where the end customers purchase it. This example displays the present-day globalized world, where raw materials and components are extracted from many countries. The most serious difficulty for a company is to create circularity within its supply chain, so the exploitation of raw materials is not required. Instead, the consumers bring back the power drill when reaching its end-of-use phase, and its material will be refurbished to produce

a new one. Introducing a circular economy within a company is manageable. However, on a supply chain level, there is an expanse of suppliers and manufacturing sites, so it is incredibly problematic to create a closed-loop.

The most frequent dilemma is geographic leakages when implementing a circular supply chain. Therefore, four archetypes will be introduced to facilitate the analyses of the leakages (WEF, 2014):

	China ¹	Europe ²	Description	Case examples
1 Closed global/ local/ regional loop			Global closed loops <ul style="list-style-type: none"> End-of-use products or components are collected and returned to the countries where they were manufactured to be used in production of the same or similar products, largely at recycled material level 	Ricoh used plastics return H&M respinning of fibres for jeans Airplane jet engines for reuse
			Regional closed loop <ul style="list-style-type: none"> Products are mostly maintained in countries where usage takes place Some end-of-use/pre-owned products are collected, re-engineered/remanufactured regionally, and sold into local markets 	SAB Miller bottled beer distribution Desso closed-loop carpet tile
2 Partially open local/ regional loop			<ul style="list-style-type: none"> End-of-use products or components are collected and returned to manufacturing facilities in the same regions to be used in the production of the same or similar products 	Renault engine and gearbox refurbishment B&Q power drill repairs
3 Open cascade			<ul style="list-style-type: none"> For some valuable products, end-of-use materials are collected and sold to secondary markets, where material flows/end-of-use are not regulated, resulting in significant leakages 	Brightstar used mobile phone distribution i:CO sale of used clothes
4 Linear			<ul style="list-style-type: none"> End-of-use products are discarded in landfills or incinerators of countries where consumption takes place 	Relevant for 80% of materials used in FMCGs

¹ Or other manufacturing countries; ² Analogous to the US and other Importing regions

Fig. 17: Archetypes of supply chains and loops (WEF, 2014)

6.5.1. Closed & global/local/regional loop

Closed geographical supply loops mean that products turn back from the country where they were used to the country where they were produced to minimize raw materials. That works primarily for an immense mass of products.

This thesis differentiates between closed regional and local loops and closed global loops.

Closed global loops do hardly exist in practice. The figure shows that companies collect end-of-use products in Europe and send them back to China, where they were produced. The production facility manufactures new products from the old materials.

Nowadays, it is only manageable for high-value products like airplane jet engines, although the outermost cycle recycling could also accomplish this concept. For example, there is a balanced market between point-of-use and manufacturing for fiber stream for paper and cardboard. In Asia, facilities reuse them to produce packages for export products. That is cheaper than providing fiber from raw materials, but recycling generates the most negligible value in the circle theory (WEF, 2014).

Many companies recognized by the time that closed global loops feature many advantages. Containers shipping back from the US or Europe to Asia are almost empty. Therefore, these routes could be operated to give end-of-use products back to the manufacturing sites in Asia. The transportation costs are manageable because the ships need to get back to Asia no matter what. Consequently, new products can be produced from these materials without extracting new raw materials (DHL, 2022).

Market volume 2021 – 2025

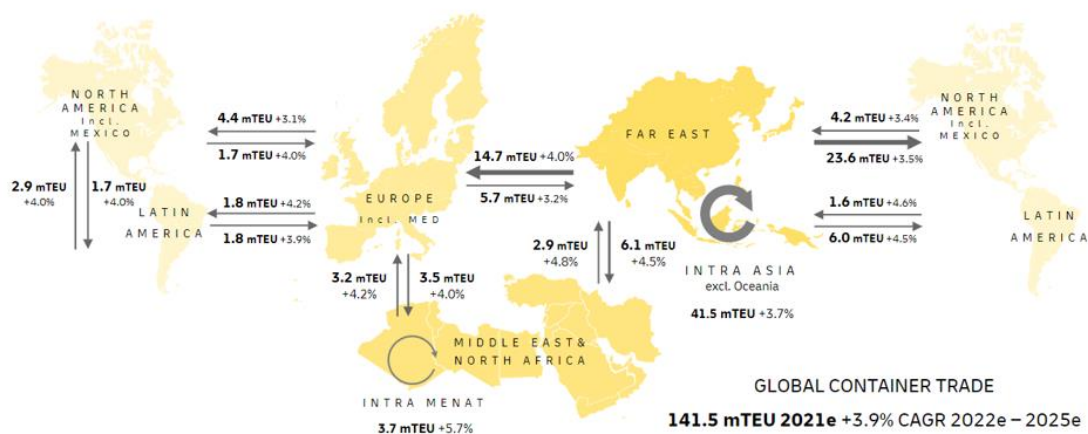


Fig. 18: Global Container Trade (DHL, 2022)

From 2021 until 2025 economy expects an even higher global container trade market value. It will increase by 3,9%. It demonstrates that the container trade from Asia to Europe will soar by 4%. Although the other way around, it rises 3.2%, there is still a difference of 9 mTEU, which should be used to total capacity. The same problem occurs from Asia to North America and back. Asia ships 23.6 mTEU to North America, but it just transfers 4.2 mTEU back. So, the two countries develop an extreme gap. Interestingly, the container shipments between Europe and Latin America are balanced and increasing steadily.

The illegal electronic waste trade is a big challenge for the economy. Therefore, it is still impossible to introduce a completely closed global supply chain (WEF, 2014).

Closed regional and local loops define that the point-of-use and manufacturing belong in the same region as Europe. Due to the proximity of the two points, transportation costs are pretty low. The below figure shows an example of the loop of returnable bottles.



Fig. 19: Loop of returnable bottles (AK Mehrweg GbR, 2022)

Mineralbrunnen is a German beverage producer and shows how their sparkling water bottles are reused in Germany. Firstly, the company starts to fill empty bottles with sparkling water. Then they are looking for quantity buyers, and the bottles are brought through a truck to buyers' storage and distributions. There the bottles are allocated to different supermarkets to be sold. End customers are buying the sparkling water, but they have to pay a small deposit, so it will be assured that the consumers bring the bottles back to the supermarket. After returning the empty bottles, a truck picks them up again and returns them to Mineralbrunnen. Finally, the company cleans the bottles again and closes the loop by refilling them and giving them back to the quantity buyers.

The example describes the possible creation of a closed regional loop with simple products. Only trucks are necessary to deliver the products, so transportation costs are pretty low. Also, the supermarkets which sell the water are closed. If these kinds of products start to create loops, a circular supply chain can at least be introduced regionally.

6.5.2. Partially open local/regional loop

Regarding figure 17 mentioned above, partially open geographical loops imply that raw materials are extracted to be used to manufacture the products in China. Then the products are sent to Europe, which is the point-of-use. If a product reaches its end-of-use level, it will be given back to the company and will be refurbished, and will be reused in Europe. That means this model is a hybrid concept because, in China, the approach is still linear, but in Europe, it is transforming into a circular one. Nowadays, many companies prefer this hybrid approach (WEF, 2014).

The before-mentioned example of Evocycle describes one of these loops. In Asia, the HP manufacturing facility produces new cartridges sold on the European market. HP in Europe tries to get back the empty cartridges through different programs and contracts. For instance, Evocycle cartridges are refurbished in Bretagne and resold in the French Market.

6.5.3. Open cascade

The archetype open cascade has no closed loop. For example, in figure 17, products are manufactured in China and are brought to Europe. Over there, customers utilize them until they pass the end-of-use phase, and then these products are sold to other markets (WEF, 2014).

These markets are mostly Third World countries like India. It is eye-catching that this material flow usually goes from northern to southern regions. These countries do not own enough resources to assimilate e. g. well-worn clothes to fiber. Additionally, there are fewer regulations instructing what should happen to end-of-life products. Therefore, they are thrown into landfills, and no loop is created (Norris, 2015).

However, recycling expands the product's life cycle only for a short period, which is not the purpose of a circular economy. Nevertheless, many companies only consider the

opportunity to earn more benefits immediately, which does not advance circularity (WEF, 2014).

6.5.4. Linear

The linear archetype is still the traditional one. Figure 17 demonstrates that products are produced in China and used in Europe. Customers throw them directly into the landfill without passing one of the loops – repair, reuse, refurbish or recycle. At least open cascades fulfill the loop recycling once. Indeed, in the global textile sector, 80% of clothes are thrown into landfills. Customers bring only 20% of their clothes to collection points (WEF, 2014).

As long as consumers and companies do not rethink and only consider their conveniences and profit, designing an indeed circular supply chain will not be easy.

6.5.5. The best option for a circular economy

The explanation of the four archetypes shows that combining options one to three leads to a stable circular economy. However, the leakages increase the loss of product value, materials, or resources. Practical experiences are the most critical challenges. A supply chain contains not just one actor but several that have to work together to cover these leakages. If the supply chain becomes more global, it is even more difficult to keep closed loops. At the moment, a closed global supply loop implies higher transportation costs than a regional one. Therefore, exploiting the return routes of container ships is essential to exhaust their full potential (WEF, 2014).

The below figure describes again the different types of supply chains – a linear, a closed, and a circular. The linear supply chain includes no loop but only the primary resource and waste flow. On the contrary, the closed-loop one shows that a loop is created if customers give back their products to the producers. Finally, cascades are necessary to generate circularity. That means that products are also streaming to other sectors or rather markets, but they need to be returned from there to continue the circular flow (Farooque et al., 2019).

How could a circular Supply Chain management help to advance circular economy?

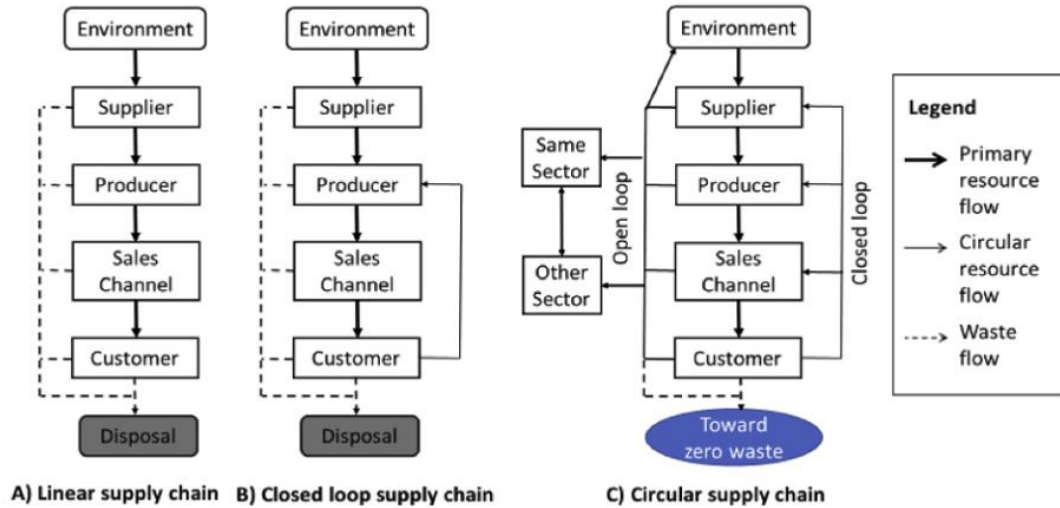


Fig. 20: Linear, closed-loop, and circular supply chains (Farooque et al., 2019)

However, leakages on different supply chain levels must be avoided to obtain a closed loop. The table below explains various supply chain stages, their tasks, and every stage's input and output flow. Additionally, it shows which leakages are generated during these activities. For clarification, the stage distribution and sales, meaning the sales channel, will be considered an example. This activity is about the storage of the inventory. This stage serves to sell the end products through the distribution to end customers. As a result, leakages can be established through unsold, damaged, and waste products (Bianchini et al., 2019).

Supply Chain Stage	Core Activities	Input Flow	Output Flow	Leakages
Manufacturing	Transformation process	Raw materials	Components/parts; bio-based product	Rejects; non-compliance
Assembling	Assembling of n parts into a final product	Components/parts	Final products; waste/wastage	Damaged/wrong parts
Distribution & Sales	Storing inventory	Final products; bio-based products	Sold final products (including bio-based)	Unsold, damaged, waste products
Use	Use and consumption of final products	Final products; bio-based products	End-of-life final products and waste	Unexploited or not consumed products
Maintenance	Restoring initial conditions of products	End-of-life products	Restored products, parts and materials	Unrecoverable/damaged products and materials
Collection, Recycling and Energy recovery	Reprocessed materials with low properties	End-of-life products and waste	Materials and energy	Unrecoverable waste/wastage

Table 1: Typical stages in a generic supply chain (Bianchini et al., 2019)

All supply chain actors must find a solution to avoid these leakages shown in the table to reach zero waste. Sustainability and the prevention of emissions and damage to the earth are in all supply chain's actor's interests. Nevertheless, supply chain activities are still crucial originators of climate change. That is why the parties must learn to work together despite their mistrust. Therefore, there is not just one best option for the archetypes; an interaction of several ideas can close the loop and lead to circularity. The following bullet point will explain what collaboration in a supply chain means and how essential it is to create a circular one.

7. Importance of collaboration within a circular supply chain

Five concepts are vital to applying a circular supply chain – circularity in business models, reverse logistics policies, vision and learning in circularity, connection in a circular supply chain, and collaboration. Collaboration is seen as an enabler to reaching within the value chain a transformation to a circular supply chain. Nevertheless, there is not enough company experience regarding a circular supply chain; therefore, actors do not know precisely how collaboration works nowadays (Tseng et al., 2022).

However, trust among the actors is crucial to implementing collaboration. They need to be sure that their private information is secured. That means that confidentiality,

privacy, and anonymity are necessary. Organizations operating outside their company's boundaries can determine many benefits and increase their values. Accordingly, companies recognize the opportunities and improve their technologies, so collaboration with their supply chain partners is possible. Nevertheless, there is still a considerable mistrust that sensitive information will be passed to competitors (Barkataki & Zeineddine, 2015).

Therefore, supply chain managers require frameworks to share information with buyers and suppliers securely. This framework should contain (Barkataki & Zeineddine, 2015):

- Confidentiality between supply chain actors
- Anonymity when sharing information
- Privacy
- Verifiability of information
- Non-repudiation of correct information

Nevertheless, a circular supply chain occurs when a circular economy is implemented in a supply chain. Consequently, forward and reverse logistics must work simultaneously, which demands collaboration between the supply chain actors. In this way, used products and waste create value. The collaboration expects transparency in data management and materials flows and a contract to share benefits and the same purposes among the partners.

Die authors Tseng, Ha, Wu, and Xue define how collaboration can be introduced in a circular supply chain:

“From the organisational learning theory, the better vision and achieved knowledge were admitted as an enabler of firms to react to changes and intensify the collaboration with the partners in CSC, in consequence, firms are recommended to their vision and knowledge in climate of high commitment to learning” (Tseng et al., 2022).

As a result of this, the authors are developing theoretical approaches which serve to introduce collaboration. These are organizational learning, resource-based view, and organizational change.

Organizational learning explains how circular supply chain activities can cooperate better through improving awareness, knowledge, and vision. Hence the company opens up to new opportunities and prepositions within the circular supply chain. Furthermore, the organization collects experience through organizational learning and finds its way step by step to react faster to environmental changes. That is a big difference compared to a linear supply chain. However, it is a learning process to reach the capacity to perform a fluid transition from linear to circular. As a result, the relationship between a company and its partner intensifies through sharing knowledge and a future mutual vision. Ultimately, they develop collaboration in their circular supply chain (Tseng et al., 2022).

Resource-based view means that companies already own specific resources. Thereby, they can achieve efficient strategies and capabilities to advance their performance, create strategic objectives and generate a competitive advantage. These organizations mostly accomplished their resources through inter-organizational cooperation and relationships with partners and suppliers. However, they need these relationships, connections, and integration to evoke the desired collaboration in the supply chain. Additionally, innovative business models are required to gain circularity because the resource-based view refers to the corporate strategy (Tseng et al., 2022).

Organizational change corresponds to intentional tasks that affect a company's changing process. These tasks are daily work routines or current business strategies. It shows the transition of present-day organizational goals to the desired ones. Therefore, innovative technologies are recommended to enable collaboration in the supply chain (Tseng et al., 2022).

Although theoretical approaches to collaboration within a circular supply chain exist, there are still not many successful ones. However, collaboration is one of the most crucial enablers for introducing a circular supply chain and advancing the economy. The following motives explain why collaboration is still failing (Kampstra et al., 2006):

Time span

Companies think that the biggest challenge of collaboration is network integration, but it is time. It requires much time for companies to adapt their processes to customers and suppliers, and the other way around, an adaption is obligated as well.

IT infrastructure

Companies' IT technology is often outdated, so joint sharing and collecting of data and information are onerous.

Trust

Companies do not trust each other and cannot be persuaded to share their information, technologies, or processes. That is a cultural issue and can differ from country to country.

Organization design

The operational business is often handled before strategic business because priorities are not managed well. It requires an elaborated corporate strategy to facilitate collaboration.

Competition

Companies are bothered that their suppliers can become competition, and they would have access to essential core information and data through collaboration. In addition, the organizations worry that they cannot react fast enough to the competitive environment because they depend on a collaborative supply chain.

Fear of external pressure

Especially SMEs fear that significant concerns are taking advantage of them by pressing the margins when collaborating.

Powerhouse within organization

Within a company, there are hierarchies. That means the departments compete for positions like procurement and sales or marketing and manufacturing.

Financial

Collaboration demands long-term contracts, which are challenging to represent financially. The companies think more about their short-term business.

Other reasons

For example, collaborative partners have different aims and values.

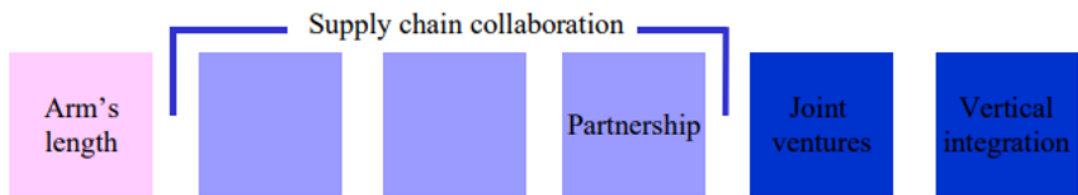


Fig. 21: Types of relationships (Kampstra et al., 2006)

There are different relationship types among supply chains with different degrees of collaboration. Therefore, the figure above indicates four diverse relationships. Firstly, arm's length means that the actors are just processing transactional business. Consequently, there is no level of collaboration at all. Secondly, joint ventures exhibit a certain level of collaboration through shared ownership. The same goes for vertical integration. Finally, collaboration is built from several partnerships, as the figure describes (Kampstra et al., 2006).

However, a high degree of collaboration between actors is required to implement a circular supply chain. Therefore, the author Kampstra, Ashayeri, and Gattorna recommend the so-called ladder of collaboration. The level of performance shows the current level of collaboration among the partners and the targets they have to achieve to climb up the ladder. All actors must reach the sub-targets, so the entire supply chain rises on the ladder. As seen below in the figure, transformational changes are, for example, improving the IT infrastructure.

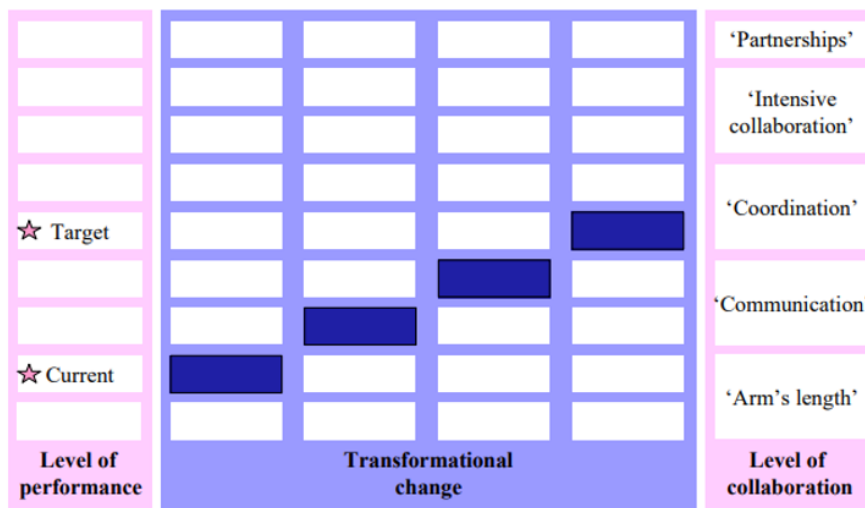


Fig. 22: The ladder of collaboration (Kampstra et al., 2006)

On the right side of the figure is the level of collaboration.

Arm's length does not include collaboration but is only a transactional business, as explained before.

Communication also does not imply collaboration but is the beginning of a relationship. Companies try to share first information among the supply chain. As a first result, productivity increases. The introduction of a simple IT system would support here to predict an expected forecast. At this stage, the aim is to decrease the joint inventory to save costs (Kampstra et al., 2006).

Coordination shows the first degree of collaboration. The supply chain actors automatize their routine decision-making processes and synchronize their material flows. Therefore, they are creating simple decision-making concepts. Improving their IT infrastructure and planning modules is crucial to advancing this level.

A high degree of collaboration is reached on the level of **intensive collaboration**. Strategic decision-making processes are framed together, and innovation is introduced into the supply chain. The parties start to trust each other, which generates an open dialogue. This degree of collaboration is not only found within logistics but also in other supply chain activities. Therefore, it is easier to bring the products back into the loop. The supply chain actors are searching together for solutions to how less raw materials are required for manufacturing. Nevertheless, the challenges of this stage are policy restrictions within the different members of the supply chain (Kampstra et al., 2006).

Partnerships are the highest level of collaboration, the goal of a circular supply chain. The actors share investments, profits, and even more critical information to progress innovations. Thus, it is possible to design joint loops and expand the product life cycles. Raw materials are barely added because collaboration works very well, so the products are reused or refurbished and come back into the cycle (Kampstra et al., 2006).

Nowadays, this high level of collaboration is infrequent within supply chains. There are not enough theories or experience for which circular supply chains can hardly be found in practice.

Therefore, the following bullet point analyses the German market and if companies over there are thinking about circular supply chains or on which level the market stands.

8. PESTEL-Analysis

After analyzing how a circular supply chain works and how it would advance a circular economy, the thesis will evaluate the German market if circular supply chain management could be applied. That means it will find out if the market has certain conditions to implement a circular economy.


Therefore, a survey was created, and 62 companies were asked to refill it. The survey was anonymous, but mainly the logistics department was questioned. The companies are SMEs, but also some concerns answered the survey. The questions were focused primarily on sustainability and circular economy. It was structured in a way so that a circular economy was approached step-by-step. Therefore, even if a respondent did not necessarily know the phrase "circular economy or reverse logistics," the responses indicated whether initial measures had been taken in this direction.

Most companies are performing a PESTEL analysis for such a macro analysis. PESTEL stands for Political, Economic, Social, Technological, Environmental, and Legal, which describes the external factors of a market. These aspects are evaluated because they do not depend on a company's size and influence its cost structure or supply and demand, for example. Therefore, a PESTEL analysis aims to detect opportunities and understand the market's growth. Additionally, the position among the market competitors can be found (Wan Ahmad et al., 2017).

Most of the surveyed companies supply different sectors, not just one.

How could a circular Supply Chain management help to advance circular economy?

Which kind of industries are you supplying?

 Kopieren

62 Antworten

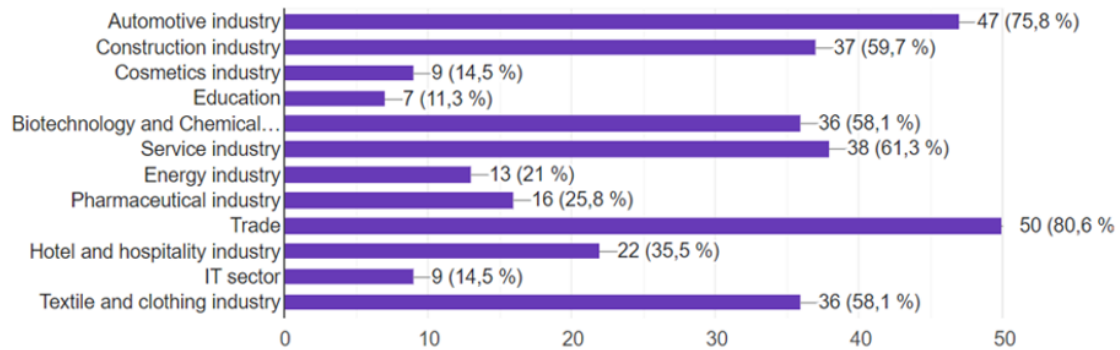



Fig. 23: Which kind of industries are you supplying?

The most crucial sector in Germany is the automotive industry. 75,8 % of the companies are supplying them. Only trade is provided with more products with 80,6 % to deliver, for example, food to supermarkets. The service industry, which has been growing fast over the last few years, is supplied by 61,3 % of the questioned organizations. In addition, the construction and biotechnology industries are represented by almost 60% as well. In Germany, the IT Sector is not very present, so just nine companies answered that they are supplying them.

Of course, companies were directly asked if they knew circular economy because the thesis mainly treats about it. However, SMEs are remarkably unaware of this concept, so just 62,9% of the respondents said yes.

Have you ever heard about circular economy or reverse logistics in general?

 Kopieren

62 Antworten

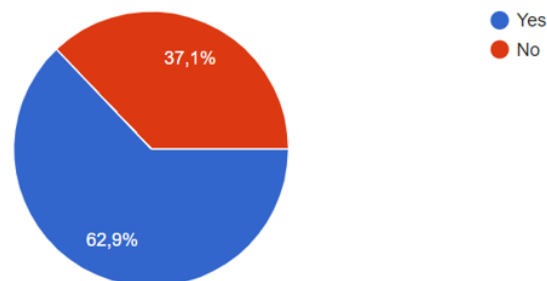


Fig. 24: Have you ever heard about circular economy or reverse logistics in general?

However, as mentioned before, the survey's aim was that, although companies do not realize the term circular economy itself, they may unknowingly try to close loops by simply reusing the packaging the organizations take back.

Now, the thesis tries to determine if a circular supply chain and generally a circular economy is possible in Germany by applying the PESTEL analysis.

Political:

Germany's political situation is very stable because they have a democratic state. Moreover, Germany depends on the European Union, which has many advantages for a circular economy because companies can act barrier-free in the whole region – from production to supply. Furthermore, the EU negotiated many free-trade agreements with different countries, simplifying a global supply chain. Additionally, the material flow is guaranteed as well. For example, in 2019, the EU and Japan have agreed to a mutual free-trade agreement called JEFTA. This agreement contains that customs are disposed of, favoring the material flow (Felbermayr et al., 2019). Nationally, Germany applies a free market economy, so independent trade is possible without any barriers regarding the government.

However, in 2021 almost 15% of eligible voters elected the green party, which is part of the government now. That shows that sustainability has been a crucial topic for the habitats in the last few years. Hence, it benefits the implementation of a circular economy because the consumers' acceptance is the basis.

On special occasions, the German government intervenes. For instance, they declared a strict lockdown on the economy. Therefore, companies were asked on a scale of 1 to 5 how deeply they were affected by this lockdown, meaning five influenced the most. 56,5 % of the questioned companies indicated a four on the scale because the government's lockdown harmed the economy. Supply chains were interrupted, hence the progress of making them circular. Nowadays, in Europe, companies are still struggling because of the lockdowns in China. They affect German supply chains deeply because many manufacturing sites are closed.

Has the Corona Pandemic affected the reverse logistics or rather the sustainability in general of your company? [Kopieren](#)

62 Antworten

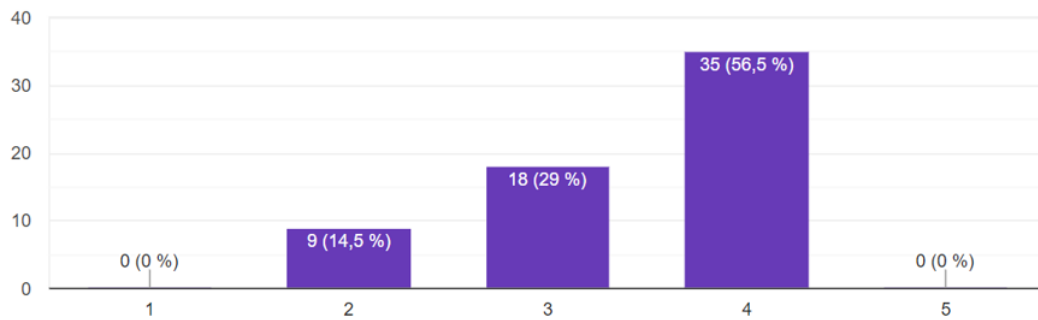


Fig. 25: Has the Corona Pandemic affected the reverse logistics or rather the sustainability in general of your company?

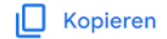
Overall, from the political side circular economy is supported. German politicians see the need to change from a linear to a circular economy. They are trying together with the EU to facilitate global supply chains by negotiating more free-trade agreements.

Economics:

In Germany, the purchasing power is very high because the GDP per capita is high. Compared with other European countries, Germany is in third place regarding average salaries (Statista, 2018). Constant economic growth is expected due to a high BIP, although now a decline can be observed because of the pandemic, war in Ukraine, and high inflation rates. The inflation rate has risen very high compared to the last few years. In May 2022, it increased to 7,9 %. That means that the economic cycle is weakening, and a recession is looming in Germany.

Therefore, companies could invest in other topics than circular economy due to the economic weakness because the priorities are a stable profit and keeping their workers. As explained before, SMEs do not know circular economy or reverse logistics, but concerns are already advertising about reusing plastic, for example. If companies try to implement a circular economy, they have specific challenges. Therefore, most of them were picked in the planning phase.

If yes, which challenges are you facing by implementing reverse logistics or rather circular economy?



62 Antworten

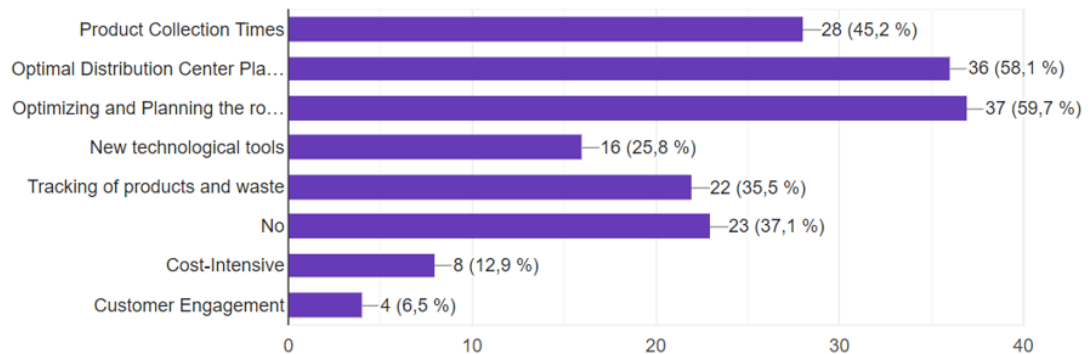


Fig. 26: If yes, which challenges are you facing by implementing reverse logistics or rather circular economy?

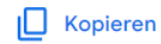
It is problematic to plan a circular economy and find the perfect location for distribution centers because the companies also depend on their supply chain partners. Almost 60 % of the organizations are facing these problems. Routes must be optimized and planned because it is crucial to know if container ships, railways, or highways are the best option. Companies must look for supply chain partners who can access these resources. Forward and reverse logistics must interact accurately, which is only possible with good collaboration.

45,2 % of the questioned companies have also seen a problem in the product collection times, which is often transferred to third-parties companies in the supply chain. Additionally, eight firms have noted that introducing a circular economy is very cost-intensive, and four mentioned that customer engagement was not very supportive. In fact, at the beginning of the circular economy, it is hard for SMEs to bear the costs when they must take care of the product collection by themselves and depend on their customers' collaboration.

In general, companies recognize that they must invest in sustainability in the future, so more than 80% of the respondents support this point.

How could a circular Supply Chain management help to advance circular economy?

Are you planning to invest more money in sustainability and circular economy?



62 Antworten

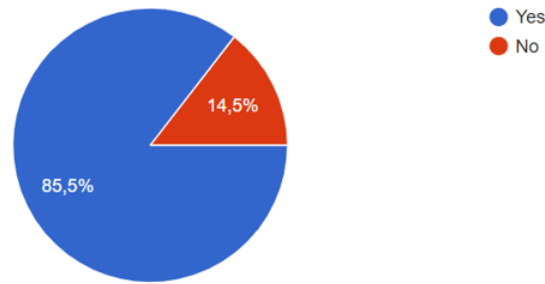


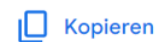
Fig. 27: Are you planning to invest more money in sustainability and circular economy?

As a result, German companies want to invest more in sustainability, so they are supportive of a change in the economy. However, there is just a lack of information to advance the transformation from a linear to a circular economy.

Social:

Inhabitants of Germany are thinking more about the environment nowadays. The authors Morrison and Beer study to find out which type of person is more environmentally aware. For example, people with a higher education degree are more sustainable thinking. In Germany, one-third of the citizens have been absolved from university. Therefore, this topic is very crucial and is reflected in purchasing behavior. They value sustainability and companies which have included that in their code of conduct.

How important is sustainability in your company?



62 Antworten

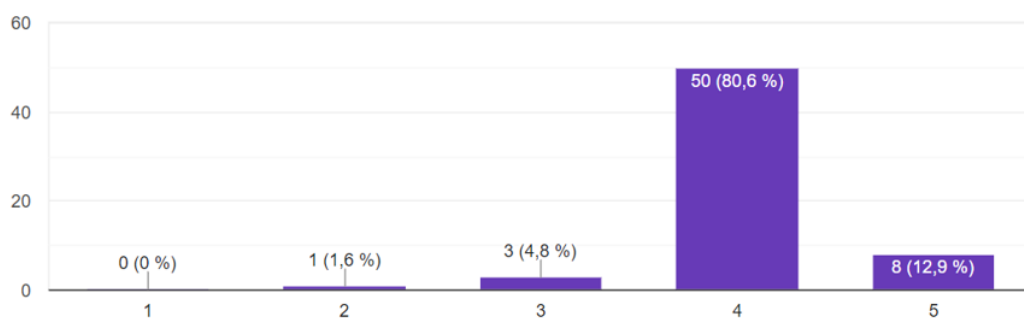


Fig. 28: How important is sustainability in your company?

German companies recognized this trend, so on a scale of 1 to 5, where five describes that sustainability is fundamental, 50 out of 62 informants gave it a four. Furthermore, eight companies selected a five, and only 6,4 % would consider sustainability less. Therefore, more than 80 % determine sustainability in their code of conduct.

Is sustainability part of your company's Code of Conduct?

62 Antworten

 Kopieren

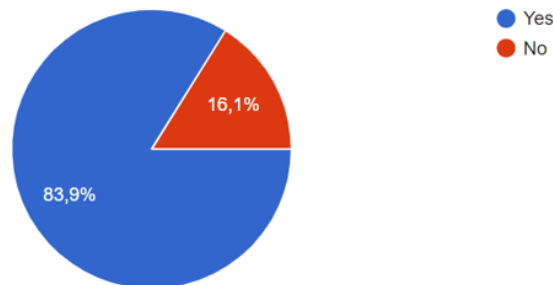


Fig. 29: Is sustainability part of your company's Code of Conduct?

Consumers in Germany generally accept green products, but there could be a constraint on reused or refurbished products. Status symbols are crucial to the citizens, so changing a more circular business model could fail in the end. There is also the necessity to clarify the situation of the present economy and pressure to a more circular one.

Technology:

Germany has a well-connected infrastructure. Hence, logistics is well positioned with a globally linked port such as Hamburg, a well-functioning rail network, and fast-moving trucks through an excellent highway system. Moreover, there are no tolls on roads.

Therefore, 55 respondents invest more money in alternative drives, almost 90 %. However, the challenge is that the infrastructure for alternative drives is still weak. For example, there are hardly any plug sockets for electronic cars.

How could a circular Supply Chain management help to advance circular economy?

Do you have any climate targets within your company? If yes, please choose which ones: [Kopieren](#)

62 Antworten

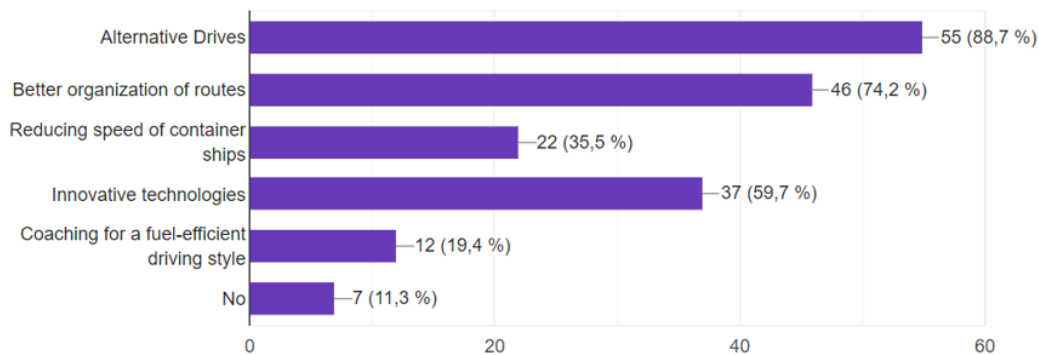


Fig. 30: Do you have any climate targets within your company?

74,2 % of the informants also chose to organize routes better to reach their climate targets. Additionally, 37 companies invest in innovative technologies where a better IT infrastructure is required. In Germany, IT technology is outdated. Thanks to the Covid pandemic, digitalization has advanced a lot. Only 35,5 % of the respondents picked reducing the speed of the container ships. The reason is that only a few of the questioned companies are operating in ship trading. Another idea to protect the climate is to offer training to their drivers so they learn how to drive fuel-efficient. However, only 12 % are already providing that.

Nevertheless, more companies are trying to introduce new technological tools to push the circular economy and improve company processes.

Are you using new technological tools to provide a more fluent circular economy? If yes, please choose which one: [Kopieren](#)

62 Antworten

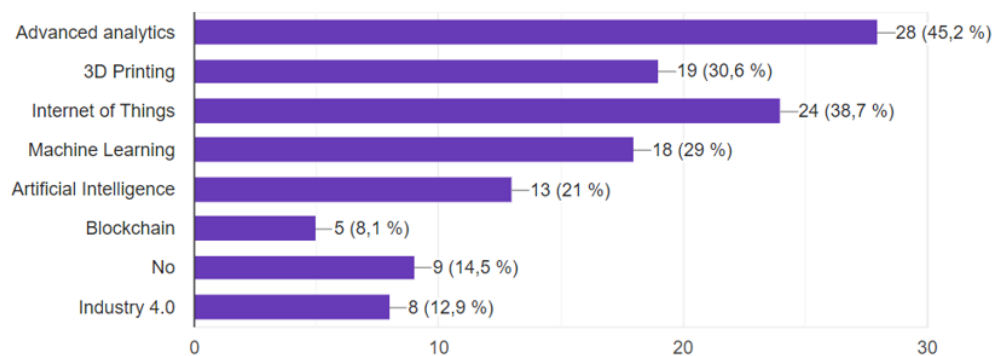


Fig. 31: Are you using new technological tools to provide a more fluent circular economy?

45,2 % have already implemented advanced analytics, and the informants also favor the Internet of Things which achieved 38,7 %. Nineteen organizations utilize 3D printing, especially in manufacturing departments, because printing spare parts are sometimes cheaper than producing them. Artificial intelligence and blockchain are not very interesting to them. Particularly artificial intelligence is still too complicated and not fully developed. Eight companies have stated that they are trying out the new technology tool industry 4.0.

A circular supply chain demands a high degree of technology to implement collaboration among the partners. However, as there is still a lack of new technologies in Germany, it could be challenging to introduce a circular economy. That is one crucial point that needs improvement in the next few years.

Environmental:

Logistic companies are one of the biggest causes of CO2 emissions. Nevertheless, as explained in the previous points, they are investing in new processes to change it. German firms are already prioritizing sustainability, and 85 % plan to spend more money on sustainability like seen before.

However, geographically Germany has a moderate climate. That is why the distribution of products within it is almost barrier-free, simplifying the supply chain. On the other hand, due to climate change, Germany is affected by extreme weather conditions. Examples include droughts, so water levels are sinking and ships cannot move anymore, or floods of whole regions. Nevertheless, Germany does not own many natural resources, so companies must import or produce them in other countries. Nowadays, creating a global circular supply chain is very complex. Moreover, the environmental factors are different.


Companies and customers want to improve the environmental conditions and reduce emissions, but Germany cannot produce daily products without imports. They depend on other countries that implement circular economies, and therefore, a global circular supply chain is possible.

Legal:

How could a circular Supply Chain management help to advance circular economy?

Finally, in Germany, contracts are legally binding, so they must comply. Accordingly, trust is easier to assemble and advances information sharing. Additionally, it exists a law about how to handle waste which originated from a European Union guideline. The first paragraph describes that it wants to support a circular economy. Therefore, the purpose of the law is to progress recycling management to protect raw materials and ensure the protection of people and the environment for the next generations.

Do your drivers use their tours to collect waste products?

 Kopieren

62 Antworten

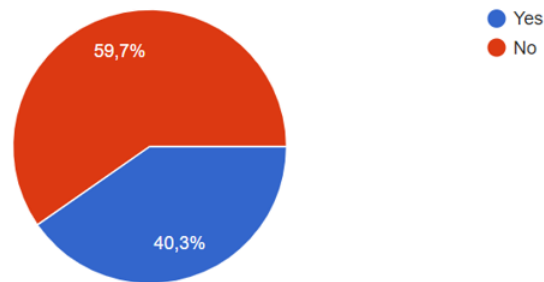


Fig. 32: Do your drivers use their tours to collect waste products?

Due to the law, 40 % of the respondents even organize their tours to collect waste products. Then they can reuse them to close the loop. However, 60 % do not take this opportunity. It is not obligated to take the waste back, but it must be disposed of properly. Almost 90 % of the companies want to give back waste products to the supplying companies.

Are these sectors interested in giving back their waste products directly to the supplying logistics company?

 Kopieren

62 Antworten

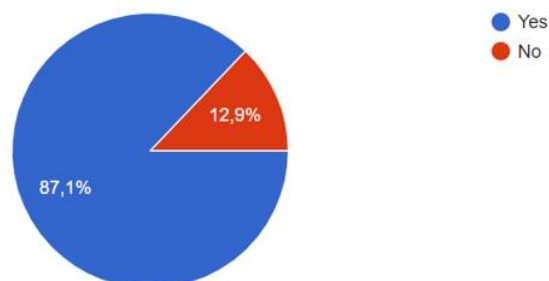


Fig. 33: Are these sectors interested in giving back their waste products directly to the supplying logistics company?

This law supports recycling, but recycling is the outermost circle, creating the most negligible value because most materials will be downcycled. Another law implies the take-back of packages in Germany. It describes that companies which are circulated industrial packages are responsible for disposing of the packaging again. For instance, pallets are excluded from the law. For this reason, almost 70 % of the informants take back their packages, and other companies hire third-party companies.

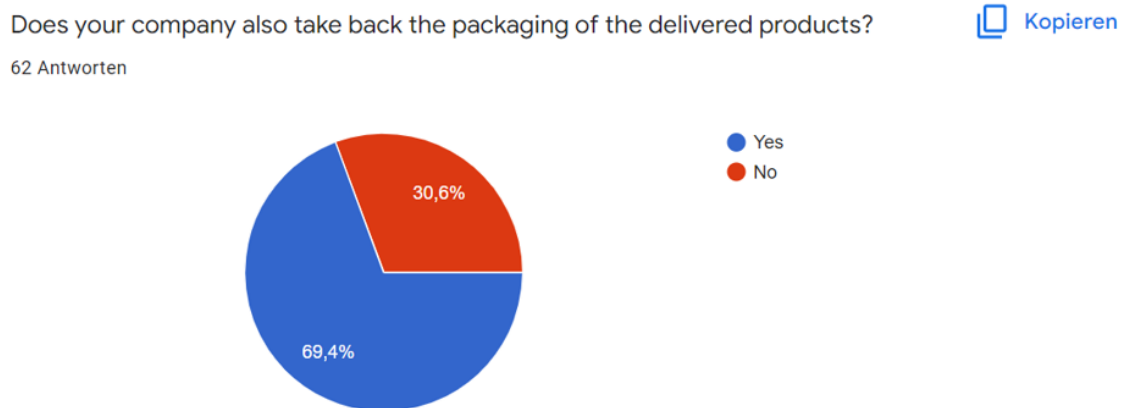


Fig. 34: Does your company also take back the packaging of the delivered products?

Nevertheless, if companies try to generate a global circular supply chain, it is precarious because of the high complexity of the countries' different legal systems. Additionally, code law is applied in Germany, but some countries practice common law. That can also be a challenge for a global supply chain.

Nevertheless, a circular economy is achievable in Germany from a legal aspect. The law even supports it. Only international conflicts can be generated due to different laws and views.

After analyzing the aspects of PESTEL, it is clear that consumers and companies want to change the economy and be more sustainable. They are aware of environmental damage and search for a solution to prevent it. Additionally, the legislative, executive, and judiciary power think about methods to apply circularity. However, the conditions

are still not entirely given because there is still a lack of clarification regarding circular economy. The most crucial factor is to improve technologies in Germany.

9. Results

Ofrecer de forma detallada todos los resultados obtenidos en el trabajo.

10. Conclusions

In the end, the thesis shows that a circular supply chain could help advance a circular economy because supply chain management does not only include logistics but the whole process from manufacturing to selling to the customers. Circularity can be secured if all actors collaborate and try to close loops. However, as explained in the thesis, companies and end customers must still learn much about the concept. They must understand that they must change so that the economy can change. That is crucial because climate change has advanced a lot already.

The PESTEL análisis shows that even a developed country like Germany still struggles to apply circularity. The lack of information persists and must be clarified. Then, it is possible to start implementing a circular economy. Nevertheless, even researchers are still looking for a perfect solution and definition for a circular supply chain.

References

- Alshamsi, A., & Diabat, A. (2015). A reverse logistics network design. *Journal of Manufacturing Systems*, 37, 589–598. <https://doi.org/10.1016/j.jmsy.2015.02.006>
- Barkataki, S., & Zeineddine, H. (2015). On achieving secure collaboration in supply chains. *Information Systems Frontiers*, 17(3), 691–705. <https://doi.org/10.1007/s10796-013-9448-3>
- Bianchini, A., Rossi, J., & Pellegrini, M. (2019). Overcoming the main barriers of circular economy implementation through a new visualization tool for circular business models. *Sustainability (Switzerland)*, 11(23). <https://doi.org/10.3390/su11236614>
- Bressanelli, G., Perona, M., & Saccani, N. (2019). Challenges in supply chain redesign for the Circular Economy: a literature review and a multiple case study. *International Journal of Production Research*, 57(23), 7395–7422. <https://doi.org/10.1080/00207543.2018.1542176>
- Campbell-Johnston, K., Vermeulen, W. J. V., Reike, D., & Brullot, S. (2020). The Circular Economy and Cascading: Towards a Framework. In *Resources, Conservation and Recycling: X* (Vol. 7). Elsevier B.V. <https://doi.org/10.1016/j.rcrx.2020.100038>

de Angelis, R., Howard, M., & Miemczyk, J. (2018). Supply chain management and the circular economy: towards the circular supply chain. *Production Planning and Control*, 29(6), 425–437. <https://doi.org/10.1080/09537287.2018.1449244>

DHL. (2022). *OCEAN FREIGHT MARKET UPDATE*.

Farooque, M., Zhang, A., Thürer, M., Qu, T., & Huisingh, D. (2019). Circular supply chain management: A definition and structured literature review. In *Journal of Cleaner Production* (Vol. 228, pp. 882–900). Elsevier Ltd. <https://doi.org/10.1016/j.jclepro.2019.04.303>

Felbermayr, G., Kimura, F., Okubo, T., & Steininger, M. (2019). Quantifying the EU-Japan Economic Partnership Agreement. *Journal of the Japanese and International Economies*, 51, 110–128. <https://doi.org/10.1016/j.jjie.2018.12.007>

Hamzaoui-Essoussi, L., & Linton, J. D. (2014). Offering branded remanufactured/recycled products: at what price? *Journal of Remanufacturing*, 4(1). <https://doi.org/10.1186/s13243-014-0009-9>

Global Footprint Network. (2021). Earth Overshoot Day. Retrieved 15/03/2022 from <https://www.overshootday.org/>

Kampstra, R. P., Ashayeri, J. , & Gattorna, J. (2006). *Realities of Supply Chain Collaboration*.

Kumar, S., & Putnam, V. (2008). Cradle to cradle: Reverse logistics strategies and opportunities across three industry sectors. *International Journal of Production Economics*, 115(2), 305–315. <https://doi.org/10.1016/j.ijpe.2007.11.015>

Norris, L. (2015). The limits of ethicality in international markets: Imported second-hand clothing in India. *Geoforum*, 67, 183–193. <https://doi.org/10.1016/j.geoforum.2015.06.003>

Rubio, S., & Jiménez-Parra, B. (2014a). Reverse logistics: Overview and challenges for supply chain management. *International Journal of Engineering Business Management*, 6(1), 1–7. <https://doi.org/10.5772/58827>

- Rubio, S., & Jiménez-Parra, B. (2014b). Reverse logistics: Overview and challenges for supply chain management. *International Journal of Engineering Business Management*, 6(1), 1–7. <https://doi.org/10.5772/58827>
- Sarkis, J., Helms, M. M., & Hervani, A. A. (2010). Reverse logistics and social sustainability. *Corporate Social Responsibility and Environmental Management*, 17(6), 337–354. <https://doi.org/10.1002/csr.220>
- Statista(2018), Durchschnittlicher Bruttomonatsverdienst von Vollzeitbeschäftigten¹ in den Ländern der Europäischen Union (EU) im Jahr 2018 retrieved from <https://de.statista.com/statistik/daten/studie/183571/umfrage/bruttomonatsverdienst-in-der-eu/>
- Tian, J., & Chen, M. (2014). Sustainable design for automotive products: Dismantling and recycling of end-of-life vehicles. *Waste Management*, 34(2), 458–467. <https://doi.org/10.1016/j.wasman.2013.11.005>
- Tseng, M. L., Ha, H. M., Wu, K. J., & Xue, B. (2022). Healthcare industry circular supply chain collaboration in Vietnam: vision and learning influences on connection in a circular supply chain and circularity business model. *International Journal of Logistics Research and Applications*, 25(4–5), 743–768. <https://doi.org/10.1080/13675567.2021.1923671>
- Wan Ahmad, W. N. K., Rezaei, J., Sadaghiani, S., & Tavasszy, L. A. (2017). Evaluation of the external forces affecting the sustainability of oil and gas supply chain using Best Worst Method. *Journal of Cleaner Production*, 153, 242–252. <https://doi.org/10.1016/j.jclepro.2017.03.166>
- WEF. (2014). Towards the circular economy Accelerating the scale-up across global supply chains. *World Economic Forum*.
- Yang, M., Smart, P., Kumar, M., Jolly, M., & Evans, S. (2018). Product-service systems business models for circular supply chains. *Production Planning and Control*, 29(6), 498–508. <https://doi.org/10.1080/09537287.2018.1449247>

ANEXOS

El apartado de anexos debe recoger toda aquella información relevante pero que es complementaria al trabajo realizado.