

POSSIBILITIES OF IMPLEMENTATION OF CIRCULAR ECONOMY PRINCIPLES IN MEDIUM-SIZED ENTERPRISES OF THE CHEMICAL INDUSTRY IN THE CZECH REPUBLIC

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Abstract

In connection with the introduction of sustainable procedures and solutions into corporate practice, new topics are coming to the fore, including the circular economy. Its goal is to reduce the consumption of natural resources in the economy, it is based on the principle of closing or circulating flows within product and material systems, even taking into account other aspects of sustainable development. To achieve the goals of the circular economy, so-called R-strategies were developed. Among the most common are the 3Rs: Reduce, Re-use, Recycle, these were gradually supplemented by strategies such as Refuse, Rethink, Repair, Refurbish, Remanufacture, Repurpose, or Recover. The transition to a circular economy thus requires innovations, new business models or social-institutional changes, focusing already on the product design phase and evaluating all phases of the product life cycle. This contribution summarizes the results of the research, the main goal of which was to find out how small and medium-sized enterprises are affected by this new direction, what activities they implement in this area, what obstacles they face, and how they perceive threats, as well as opportunities. What are the reasons for introducing the principles of the circular economy. Specifically, companies from the chemical industry were selected. The research was carried out using qualitative research methods including personal interviews and discussions with representatives of selected companies.

Introduction

The circular economy has become a key issue in sustainable development as the traditional linear model of production and consumption causes environmental degradation and threatens the availability of resources needed for economic growth. The concept of circular economy cannot be considered as a novel idea, but it has received more attention in the last 10 years, both among academics and practitioners. It focuses on the circularisation of material flows and the efficient use of resources to minimise waste and reduce consumption and dependence on primary raw materials. In the circular economy, resources are re-used, and products are designed to be recyclable and reusable, upgradable, etc. As interest in the circular economy grows, different definitions of the concept are emerging across the literature¹. According to the Ellen MacArthur foundation, the most common definition of the circular economy is as an industrial economy that is restoring and regenerative, based on the principles of eliminating waste and pollution, including the release of greenhouse gases and hazardous substances, as well as the circulation of products and materials with the highest possible value, and on the regeneration of nature². An analysis of 114 definitions of circular economy across scholarly publications showed that recycling is most frequently mentioned term, followed by re-use and resources reduction, with the least mentioned term recovery; the most frequent definitions focus on the environmental and economic domains of sustainability, and the least on the social part². According to the European Union, the circular economy aims to preserve the long-term value of products, materials, and resources by returning them to the product cycle in the post-use phase, it is also a model in which waste is minimised; it is a model of production and consumption that involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products for as long as possible³.

The principles of circular economy are often associated with the so-called R-strategies, with the 3Rs: Reduce, Reuse, Recycle being the most widely used framework for circular strategies, however, R strategies were further extended from R0 up to R9⁴ and also elaborated to implementation of circular strategies at the corporate level⁵. The lower the circular strategy number, the less materials and energy are required to implement it, thus reducing the pressure on the environment. Stahel and MacArthur⁶ recognizes a "high-value route" after the end-of-life of products, which preserves as much value as possible from used products and waste for as long as possible using R-strategies. The other route is then to try to extract atoms and molecules from them in their highest possible quality and purity for reuse, the so-called "low-value route", where various D-strategies find their application, such as: de-polymerise, de-alloy, de-laminate, de-vulcanise, de-coat, etc⁶.

The circular economy can be built on macro, meso and micro levels². At the macro level, two approaches can be used to transition to a circular economy⁷:

- Top down - legislation and policy, supporting infrastructure, social awareness,

- Bottom up - collaborative business models, product design, supply chain.

It is important to address the transition to the circular economy at all levels of the economy, including the level of manufacturing companies. The literature offers various tools to implement the circular economy in corporate business models. However, so far little attention has been paid to the design of a structured approach for the implementation of the circular economy in small and middle enterprises⁸. Chemical manufacturing companies have a specific position, which is associated with both possible the negative and positive aspects of their activities for society and the environment, as they can contribute to the transition to the circular economy of other subject actors, for example in recycling and separation processes. With the operation of sustainable chemical production, the term Green Chemistry has become established. This framework has been further elaborated into 12 or 15 principles of circular green chemistry⁹. The need is to optimize design of the process to enable efficient separation, purification, reuse, and recycling of waste products in an environmentally friendly manner, while at the same time, through the efforts of distribution links to reformulate formulations, rethink material inputs and strengthen their commitment to sustainability, chemical companies will be in an ideal position to drive their own growth while gaining a better competitive position. Active collaboration on common goals across the distribution chain will be key. For example, chemical companies can provide important advice and technical skills.

Implementing circular strategies can be a challenge for companies due to financial, technological, or organisational barriers. There is also the problem of a lack of company awareness, which can hinder the full potential of the circular economy. Obstacles of Barriers to the transition to the circular economy can be seen in various areas: cultural, legislative, market and technological barriers. They stem, for example, from the habits, consumption patterns and behaviour of the links in the distribution chain and end-users; they are related to the lack of interest and awareness of customers and the habit of operating in a linear system, with a hesitant corporate culture¹⁰. Legislative barriers are related to the lack of action, especially in the areas of ownership, finance, and transport of waste across borders¹¹. Kumar et al.¹² points to the lack of a standardized system to measure performance, ineffective recycling rules, and poor enforcement and support for legislation. Kirchherr et al.¹⁰ adds the high cost of recycled materials and the high economic cost of CE investment, etc.

Research methodology

The aim of the research was to find out how companies are affected by the onset of the circular economy, what activities they implement in this area, what obstacles they face and what opportunities the circular economy offers to these companies. The research was carried out using a qualitative analysis of two companies of the chemical industry. Both companies belong to traditional Czech manufacturing companies, producing consumer chemicals, sold both on the Czech market and in other countries of the European Union. Both companies implement both serial production and custom production with development and adjustment according to the customer's wishes. Primary data was obtained using a controlled interview with representatives of both companies, and secondary data from websites and annual reports. To evaluate the degree of implementation of circular measures in these companies, the frameworks 0-9R and Scanner of circular strategies were used.

Discussion and result analysis

Profile of the companies

The two companies have different approaches to managing their activities with an awareness of their contribution to sustainable development and the implementation of circular economy principles, and similarly have different attitudes towards the introduction of environmentally friendly products, where one only complies with legislative regulations and considers environmental products uncompetitive, while the other sees them as an opportunity and introduces practices towards sustainable development out of the owners' and management's own conviction. Only the second company has both an environmental management system and an eco-label for some products. Both enterprises, however, have a certified quality management system and food safety standards, and also pay attention to the social pillar of sustainable development, for example in the ratio of men and women in management positions or the employment of people with disabilities. None of the companies publish an annual non-financial report on sustainable development.

Use of circular strategies

The R0-R9 strategy framework⁴ and the Circular Strategy Scanner framework of Blomsma et al.⁵ was used to describe and categorize specific circular strategies in the analyzed companies.

Framework R0-R9

The results of the analysis show what strategies companies are choosing for the transition to the circular economy and what specific activities they are implementing in this area.

R0 - Refuse

- The use of Refuse strategy is often not obvious in corporate practice.
- For both companies it can be identified in the form of a refusal to purchase a new line that would only produce a certain type of product, as both companies use modular lines that can produce several types of products. This results in a reduction in a certain product amount (line) that is actually needed. In the case of these companies, there is a type of internal sharing, which extends this activity to the following strategy R1-Rethink.

R1 - Rethink

- Sharing is an important activity within the Rethink strategy. The results of the research showed that one of the companies shares its production capacity, specifically providing custom product packaging services to other companies, with the company standing on both sides, offering the service for some products and buying it for others.
- Packaging design is an important activity of this strategy to ensure that products are completely emptied from their packaging.
- The research showed that neither company uses chemical leasing. This is due to the cost of implementation, lack of capacity, and the impossibility of regenerating chemicals due to their consumable nature.

R2 - Reduce

- Both companies achieve raw material savings through optimization and regular maintenance of production facilities.
- Furthermore, in the case of precision packaging, both companies have confirmed the production of concentrated product variants mainly for the B2B market and professional use, thereby reducing the consumption of packaging materials, using the product more efficiently and reducing the number of shipments and the quantities transported.
- One of the companies further reduces the amount of material used by using the minimum possible thickness of the packaging.
- Both companies place emphasis on the possibility of precise dosing of the product, particularly through the use of measuring cups integrated in the product caps.
- A clear trend in companies is also to reduce energy and water consumption, thanks to efficient production planning so that processes with the same production technology build on each other and there is no need for frequent system flushing. A steam generation plan is used to heat the steam so that it is maximally used in as many processes as possible. The planned activity is also to save energy by changing the state of the feedstock. One of the enterprises has reduced energy consumption mainly through the installation of a photovoltaic power plant, furthermore, it uses waste heat for heating and hot water, or the enterprises replace lighting with energy saving LED bulbs.

R3 - Reuse

- Both companies apply Reuse principle in production, for example by returning products that do not meet the output control back into the production process.
- The use of take-back programmes is a common company practice, companies have packaging accounts with their suppliers - mainly Euro pallets, IBC tanks and drums are circulated.
- Reuse principles can also be applied to the use of non-standardised pallets for handling in your own warehouse or for non-standard goods. Discarded pallets and tanks are also sold to employees for personal use (the circular Repurpose strategy is also applicable here).
- The use of discarded lines for the production of smaller batches of products where production on new lines with higher production volumes would be uneconomical was also identified.

R4 - Repair

- Companies have implemented preventive maintenance plans for equipment and buildings. As such, the companies' products cannot be repaired.
- Repair activities include repairs of europallets, either by external or internal forces.

R5 - Refurbish

- The use of this strategy's activities can be found in the modernisation and upgrade of product transport pipelines, such as the replacement of manual shunts with modern electric ones, and includes the

upgrading of buildings and equipment recently carried out by both companies.

R6 - Remanufacture

- An identified activity of this strategy is, for example, the use of parts of decommissioned production facilities in the construction of new ones. However, enterprises are finding that the decommissioned equipment and lines are no longer compatible with the new ones.

R7 - Repurpose

- Companies use this circular strategy mainly through the modification of discarded lines for the production of new products.

R8 - Recycle

- The products of both companies cannot be recycled as such, due to their consumer nature, so the focus of the companies' recycling efforts is on packaging materials. Both companies aim to use packaging for their products that contains as much recycled plastic as possible and is reasonably priced. The proportion of recycled plastic is normally 30% of the total weight of the packaging, and in selected cases, according to the requirements of the foreign customer, the packaging is made of 100% recycled PET. This is due to the country's tax on imports of non-recycled plastic packaging.
- Of course, the separation of waste and packaging material within the company is a matter of course for both companies.
- Most of the packaging for both companies' products is recyclable, with the exception of the caps.

R9 - Recover

- Both companies use waste-to-energy principles. Installed waste pits have been identified, which, once filled, are taken away and incinerated in an energy recovery plant. Or the use of sludge from the wastewater treatment plant itself.

A framework based on the Circular Strategy Scanner of Blomsma et al.⁵

The research results were further organized according to the Circular Strategies Scanner by Blomsma et al.⁵, see the following Table I.

Table I
Scanner of circular strategies used by enterprises

Circular Strategies Scanner			
Reinvent			Recirculate - products/equipment and their use
Efforts to reduce resource consumption	1/1	Upgradability	1/0
Rethink and reconfigure		Reuse (for packaging)	1/1
Extending product lifetime	0/1	Repair	1/1
Access and availability (sharing)	1/0	Refurbish	1/1
Result and performance (of the service)	0/0	Remanufacture	0/1
Restore, reduce and avoid		Repurpose	1/1
<u>Raw materials for products and packaging</u>		Recirculate – materials	
Renewable resources (packaging)	1/1	Recycle (for packaging)	1/1
Recyclable materials	1/1	Recover	1/1
Secondary sources	1/1	Logistics	
Restorative resourcing	0/0	Reduction in quantity/weight of products	1/1
Non-toxic and benign materials	1/1	Reduction in packaging quantity	0/1
Lowest suitable grade	0/1	Energy	
<u>Production</u>		Energy saving	1/1
Lean manufacturing and cleaner production	0/1	Energy recovery	0/1
Pre-employability	1/0	Renewable resources	0/1
Recycling in production	1/1		
Recover	1/1		
<u>Use and operation of the product</u>			
Low consumption of resources by a product	1/1		

This framework is designed for manufacturing companies and can be adapted to companies with chemical production, specifically packaging materials were included in the Raw Materials group and activities related to production facilities were included in the Recirculation group. This framework doesn't consider the circular

strategies that cannot be implemented in enterprises due to the nature of the production and the products produced. These are circular strategies: long technological life of the product, long moral life of the product, cascading for final products, cascading by-products from production, offering multiple products from one source (production), use of unused product capacity, renewable resources (products). Due to the similar focus of the two enterprises, the use of circular strategies is similar, yet it is possible to find strategies that are not used by either or only one of the enterprises: 1 represents the first/second company that implements the given activity, 0 represents the first/second company that doesn't implement the given activity.

Assessment of perceived benefits and barriers

Benefits

Both companies perceive the benefits of implementing circular strategies primarily in the economic sphere. The most frequently cited are cost reductions associated with savings from production optimisation, reduction of raw material costs, energy costs and transport of packaging to the plant. Revenues are mainly generated from the sale of certain waste (discarded equipment, paper or packaging film). Similarly, these benefits have been reported in the literature^{13, 14, 4}. Both companies perceive a better reputation and competitive advantage associated with a better environmental profile, also mentioned by Yin et al.¹³.

Another benefit is better readiness for tightening legislation. One of the companies also expects increasing pressure from end-customers and customers, to which it can be prepared to respond by implementing circularity measures.

Barriers

Among the barriers perceived by both companies is the too rapidly changing legislation, which forces them to allocate part of their resources to changes in recipes and production processes, thus not focusing on environmental protection in other areas. Legislation burdens the costs of companies, both in terms of waste and packaging payments and in terms of innovation costs, where inputs have to be replaced by new ones, and it also triggers interventions in production processes, or the costs of monitoring the preparation of changes and the changes themselves. Another barrier that emerged from the research is the lack of positive motivation and legislative support from the state. For example, the charges for produced plastic packaging are constantly increasing, while the benefits for recycled packaging are minimal, similarly see Kumar et al.¹².

Another barrier common to both companies is the current lack of interest of end customers in organic products, due to the higher purchase price, which was also pointed out by Kirchherr et al.¹⁰. The research also revealed a barrier in the form of end customers' lack of trust in the functionality of these products. The companies then disagree on whether this is a temporary phenomenon or a long-term trend. The positive perception of this situation may stem from the fact that they have already successfully introduced a green range of cleaning products.

The market barriers for recycled materials are common to both companies. The higher price of recycled plastic packaging is significantly reflected in the final price of the product. The different properties of materials with different recycled content are associated with higher scrap rates and slower production when blowing out the packaging.

Conclusion

Although circular strategies are more visible in enterprises of the mechanical industry, it is also possible to identify circular activities in the chemical sector, at all levels of R strategies from R0 to R9. Measures can be observed in all the areas from production, logistics, energy and raw materials. Most of the implemented measures comes from normal business practice, but it is also possible to identify activities that are based on the company's innovative approach, reflecting new trends and new technologies. The COVID-19 pandemic probably also had an impact on the measures. Businesses were forced to save material due to its unavailability and look for other ways to replace it. New measures were implemented that are in line with the principles of the circular economy. A number of activities also result from valid legislation and customer requirements, or the implementation of environmental quality control systems or critical points.

In both companies, you can find certain activities that the companies do not implement, or only one does, even though their implementation would be beneficial. The reason for their non-acceptance may be a hesitant corporate culture and the habit of operating in a linear system¹⁰. These are mostly strategies where consumption habits or business models change and product design innovations or high investments are introduced. Examples of these circular strategies include:

- Offering a product as a service, which is based on close cooperation between the supplier and the customer.

- Establishing partnerships and developing circular solutions with customers (packaging-free partnership).
- Redesign of packaging towards lower material demand and sharing of free capacities, which, according to the results, was always used by only one of the companies.
- Using digital platforms for buying and selling waste, causing small changes in consumption behavior. Waste can be purchased and used by other companies as raw material for their production.
- Use of restorative resources.

The study shows that both companies are already implementing some circular strategies and measures, but are still facing some obstacles to full implementation. The main obstacles include, for example, a lack of financial resources, insufficient legislative support of circular activities, the difficulty of changing internal processes and corporate culture, and insufficient availability of technology. Although these obstacles are significant, the results also showed many opportunities, including maintaining competitiveness in the future. Research in this area can further help businesses develop sustainable and circular business models.

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