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Circular economy: Implications for supply chains and logistics management[1]

Gospodarka obiegu zamkniętego: implikacje dla zarządzania łańcuchem dostaw i logistyką

Abstract

To eliminate unsustainable resource management among countries of European Union circular economy model was established. The aim of the paper is to indicate the need to redefine the principles of supply chain and logistics management in the light of the circular economy strategies. In order to practically supplement the theory, examples of circular economy from logistics processes were described based on the 3Rs principle: reduce, reuse, recycle.

Keywords:
CE, circular economy, circular supply chain, circular logistics management

Streszczenie

W celu wyeliminowania niezrównoważonego gospodarowania zasobami wśród krajów Unii Europejskiej opracowano model gospodarki o obiegu zamkniętym. Celem artykułu jest zasygnalizowanie potrzeby ponownego zdefiniowania zasad zarządzania łańcuchem dostaw i logistyką w świetle strategii gospodarki o obiegu zamkniętym. W celu praktycznego uzupełnienia teorii w pracy opisano przykłady gospodarki o obiegu zamkniętym – procesy logistyczne oparte na zasadzie 3R: redukować, ponownie wykorzystywać, poddawać recyklingowi (*reduce, reuse, recycle*).

Słowa kluczowe:
GOZ, gospodarka obiegu zamkniętego, łańcuch dostaw obiegu zamkniętego, logistyka obiegu zamkniętego, logistyka cyrkularna

JEL: L2, O2

Introduction

In 2014, the European Commission (EC) officially announced a circular economy (CE) as a new economic model for European Union (EU). The indicated zero waste programme was a response to unsustainable resource management across the European economy (Smol, 2021). The CE was defined as the system which "keep the added value in products for as long as possible and eliminates waste" (European Commission, 2014).

Next, the development strategy adopted unanimously by the United Nations (UN) countries assumed the implementation of 17 Sustainable Development Goals on a global scale by 2030. One of them is Objective 12, namely: "Ensure sustainable consumption and production patterns", where the responsible consumption and production can be defined in accordance with the principles of CE, that is (United Nations, 2015):

1) waste generation reduction through prevention, reduction, recycling and reuse;

2) halving global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses;

3) achieving the sustainable management and efficient use of natural resources and

4) encouraging companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle.

However the UN document is not the only one that underlines the importance of CE. There are also EU and national road maps approved on local levels documents in force. Having in mind that achieving these goals might be challenging for many industries and companies one can observe that it is actually not possible without holistic view on the subject – that means from the supply chain perspective and the role of logistics management in it the circular flows in the economy.

The aim of the paper is to indicate the need to redefine the principles of supply chain and logistics management in the light of the CE strategies. To fulfil this aim, in the following part of the paper, the new approach to sustainable development in terms of the most important guiding documents is described. Then we point out the concept of CE and its main strategies. Next the need for supply chain reconfiguration in relation to the assumptions of CE is explained followed by the discussion on the main logistics operations that should be not omitted in terms of the new circular environment. The main conclusions and recommendations regarding these indications are the final part of a paper.

The essence of circular economy

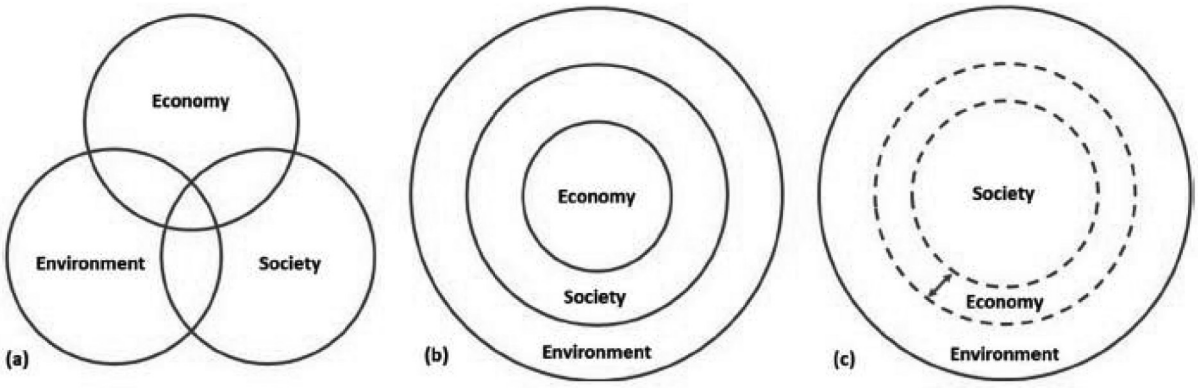
There are several main documents existing that underline the importance of sustainable development and the concept of circularity as the measure for sustainability practical implementation. One of the most important is *The 2030 Agenda for Sustainable Development*, with 17 Sustainable Development Goals (SDGs) and 169 targets that address the three pillars of sustainable development: economic, social and environmental and it had been adopted by heads of states in September 2015 (United Nations, 2015). Another document is *Closing the loop: An EU action plan for a circular economy*, that was adopted by EU in December 2015, with the key objective of a "transition to a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised" (European Commission, 2015, p. 1). Next, in November 2016, the EC outlined its strategic approach towards the implementation of the 2030 Agenda, deciding to include the SDGs in EU policies and initiatives across the board, with sustainable development as an essential guiding principle for all EC policies. Currently, the CE is one of the key blocks of the European Green Deal (EGD), which is the newest strategy for sustainable growth in the EU and aims to achieve climate neutrality on the continent by 2050 (European Commission, 2019). It was also recommended that the EU Member States should develop national strategies ("roadmaps") for the CE implementation (Smol, 2021; Smol et al., 2020).

One can observe, that in the light of CE, the perspective on sustainability concept has evolved from the triple bottom line in which economy, society and environment are considered of equal importance (a), to understanding economy as the organisation of society while both are dependent on the environment (b), and considering economy as a tool to organise resources for the purpose of maintaining or enhancing social well-being, environmental quality and economic prosperity (c) (Velenturf & Purnell, 2021) (Figure 1).

Organising resources for social, environmental and economic prosperity is nowadays one of the most important goals for managing to gain competitive advantage. Considering all of the early mentioned important documents that are building a framework for leading contemporary companies one must point out the CE concept and its strategies. CE refers to "a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops" (Geissdoerfer et al., 2017, p. 776).

Two approaches to the CE definition can be distinguished – the broad and the narrow one. The broader approach defines CE as "an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being" (Murray et al. 2017, p. 369). This assumption concentrates on the effects CE strategies have on the economy, environment, and society (Lieder & Rashid, 2016, pp. 36–51). The narrow approach to the CE definition focuses on organising resources' flows and underlines two main characteristics: closing and slowing resource loops (Bocken et al., 2016, pp. 308–320). Closing happens when "the loop between post-use and production is closed, resulting in a circular flow of resources", this means that the linear flows of waste are turned into secondary resources and are used to prevent waste generation, as far as possible, in the post-use phase. It does not preserve the product or components and includes open/closed loop recycling, downcycling, and energy recovery (Nowicka, 2021). Slowing

Figure 1
Development of sustainability perspectives



Source: Velenturf & Purnell, 2021, p. 1447.

happens "through the design of long-life goods and product-life extension (i.e. service loops to extend a product's life, for instance through repair, remanufacturing)", therefore, "the utilization period of products is extended and/or intensified, resulting in a slowdown of the flow of resources" (Moragaa et al., 2019, pp. 452–461). Closing and slowing are concentrated on reducing resources' usage and can lead to further strategies (Kirchherr, 2017).

In terms of the CE strategies, there can be several of them distinguished, i.e.: refuse (make a product redundant by abandoning its function or by offering the same function with a different product), rethink (make product use more intensive), reduce (increase efficiency in product manufacture or use by consuming fewer natural resources and components), reuse (reuse by another consumer of the same product that is in good condition and supports original functionality), repair (repair and maintenance of defective product for using it with original functionality), refurbish (restore an old product), remanufacture (use parts or components of a product in a new one having the same functionality), repurpose (use discarded products or its components in a new one but with different functionality), recycle (process components to obtain the same or lower quality) or recover (incineration of components with energy recovery) (Potting et al., 2017). At least part of these strategies can be revised in terms of supply chain and logistics management.

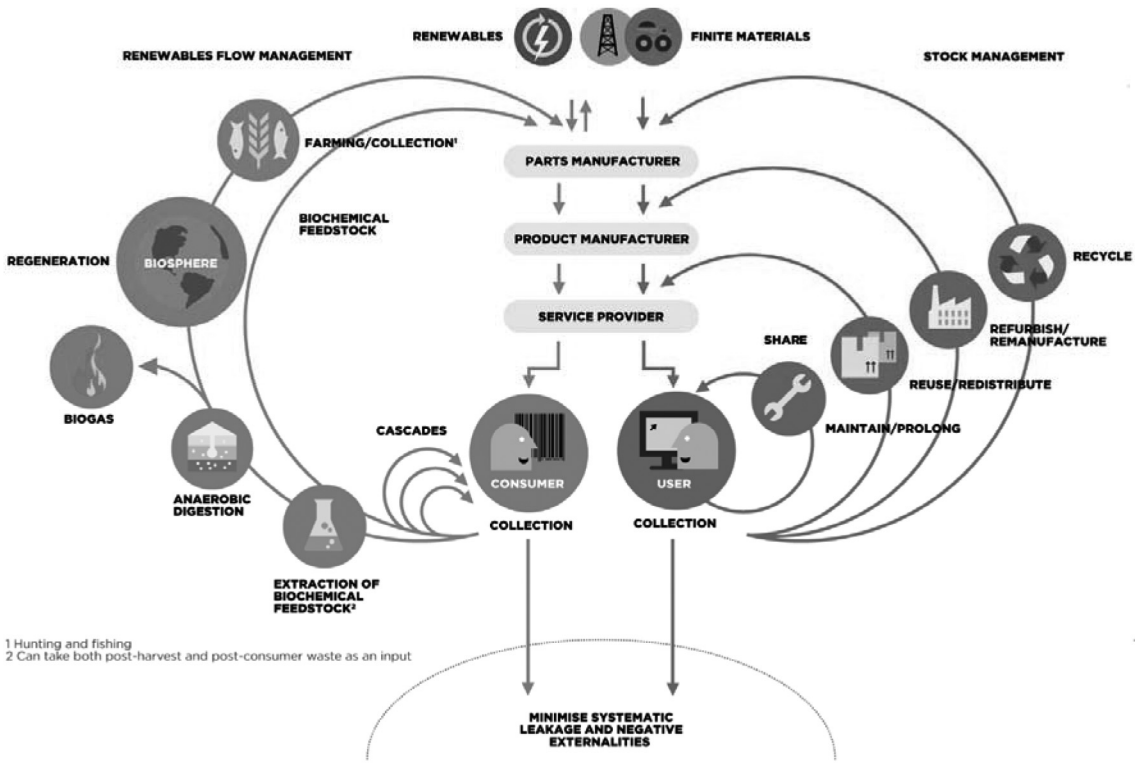
Supply chains flow in relation to the circular economy strategies

The supply chain is "a network of connected and interdependent organisations mutually and co-operatively working together to control, manage and improve the flow of the materials and information from suppliers to end users" (Aitken, 1998). Organising flows of the resources under the conditions of CE has impacted the identification and development of circular supply chains (CSC) (Pishchulov et al., 2018, pp. 267–297). CSC are able to gain in value by managing flows in different loops (Akçali et al., 2009, pp. 231–248) by i.e. closing loops, slowing loops, intensifying loops, narrowing loops or dematerializing loops. CSC focuses on the return, disposition and value recapture of post-sale products (Guide & Van Wassenhove, 2009) and its design management consists of a proactive and effective strategy for creating circular systems that facilitate the 3Rs (reduce, reuse and recycle) and emphasize environmental, social and economic requirements (Zhu et al., 2010, pp. 1324–1331).

The strategies of CE distinguished in the previous section, in most of the cases, might be a starting point for the revision of how the loops can be closed and even slowed on a different levels of supply chain flows. These potential CSC models are shown on a right hand side on Figure 2, called there as "stock management".

CSC models vary in complexity of the designed flows and in value proposition. However they can help realize the company's sustainability ambitions and goals (Geissdoerf et al. 2018, pp. 712–721) and the implementation of a CSC requires changes to design management, which can be achieved by means of a new restorative and regenerative system with less environmental impact (Pagoropoulos et al., 2017, pp. 19–24), focusing on materials, products and system design, as well as on the design for reuse (Ripanti & Tjahjono, 2019, pp. 723–742). Thus, the CSC might be easier to develop from the beginning with respect to the materials used in the

Figure 2
Circular economy system diagram



Source: Ellen MacArthur Foundation, 2013, p. 24.

product, than to reconfigure existing linear flows into the circular system. Therefore it should be underlined, that both flows indicated on Figure 2 – "renewables flow management" and "stock management" are interacting and create so called feedback in the management of these flows.

Logistics operations and management in relation to the circular economy strategies

According to the Council of Supply Chain Management Professionals, logistics management is "that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements" (CSCMP, 2022). To varying degrees, the logistics function also includes sourcing and procurement, production planning and scheduling, packaging and assembly, and customer service. In most cases, logistics management operations include transportation management (inbound and outbound), fleet management, warehousing, materials handling, inventory management, supply/demand planning, customer service and management of third party logistics services providers (LSPs). Logistics also deals with the appropriate securing of goods at the time of flow between the links in the supply chain by identifying the role of packaging. The logistics function is also involved in all levels of planning and execution-strategic, operational and tactical and therefore, as an integrating function, it coordinates, optimizes and integrates all logistics activities in relation to marketing, sales, manufacturing, finance, and information technology (CSCMP, 2022).

Therefore decisions undertaken within logistics function play crucial role in implementing solutions that improves competitiveness and sustainability of the company and its supply chains. The spectrum of decisions is very broad. Their scope could cover

selection of the means of transport and set up routes, methods of securing the transported goods or even redefine current processes.

Based on principles of CE and 3Rs it could be assumed that reverse logistics is directly connected with this issue. One of the proper example what changes in logistics management is needed, related to CE development, is deposit system. It will be introduced in Poland at the beginning of 2025. The basis for introducing the deposit system in Poland was the Directive of the European Parliament and of the Council of the European Union 2019/904 on reducing the impact of certain plastic products on the environment (SUP Directive). It imposed on Member States the obligation to ensure selective collection for recycling purposes.

To avoid additional fees or penalties, companies should adjust their processes and infrastructure to have a possibility to collect waste and organize reverse logistics actions. By building strong connection between markets and producers, waste will be collected and reused. To ensure effective functioning of deposit system twelve manufacturers: Coca Cola HBC Polska, Colian, Zywiec Zdroj, Grupa Maspex, Nestle Polska, Pepsi-Cola General Bottlers Poland, Red Bull, Oshee Polska, Zbyszko Company, Orangina Schweppes Polska, Naleczow Zdroj and Wan Pur agreed to establish common entity to manage proper reporting for this new system (Kamińska, 2024).

At the end, a big challenge is encouraging the society to use such a solution. For sure, it is doable due to increasing awareness about the negative impact of industries on the environment. In the context of CE, such an initiative refers to the reuse strategy. Implementation of closed-loop model in supply chain implicates some challenges in their processes. For sure, to be more aware in which directions it is developing, new KPIs should be established For example, for deposit system introduction it is agreed to achieve specific levels of separate collection of packaging and packaging waste within the system (77% from 2025 and 90% from 2029). Those targets require building advanced logistics flow which covers all movements of produced volume between manufacturers and markets above 200 m^2.

Continuing the consideration regarding reuse solutions, it is worth mentioning reusable transport items. "Manufacturing, storage, and transportation processes are typically facilitated by pallets, containers, and other reusable transport items (RTIs) designed to guarantee many cycles along a lifespan of several years" (Accorsi et al., 2019). Following this statement, enterprises could potentially create a closed-loop cycle through, for example, pallet management. One of the leaders in pallet pooling is CHEP. This idea requires the implementation of repairs of damaged pallets by pallet owner. But finally, cooperation with final customers of pallet renters is tangible due to possible CO_2 reduction or less wooden waste (Fratczak et al., 2019). Implementation of such a solution has an influence not only on logistics but also on production processes. It is especially visible when a company decides to introduce new pallets to end markets. To eliminate additional activities into warehouse, the operator of cartoners is responsible for using a proper type of pallet in reference to the market and project assumptions. The circular economy among RTIs is also creating new processes related to the reverse logistics. To generate benefits from this model, it is necessary to deeply analyse the costs of picking up pallets from customers.

It is worth mentioning the portfolio of the innovative company, which produces and sells a various reusable transport items. A case study with Volkswagen Kassel shows that the pallet lid is the most secure, versatile and cost-effective method of securing the load on a pallet, no banding or stretch wrap is required (Loadhog, 2022). It is a solution that brings added value to packaging process in the context of circular economy by replacing disposable lids and foil stretch with durable plastic lids and reducing waste also. The second benefit is shortening the time of securing cargo. The difference could be calculated by comparison time for wrapping by foil stretch and mounting the cover on the transportation unit. From reverse logistics perspective, usage of RTIs create additional movements between warehouses and factories. On the one hand, the level of waste is reduced but on the other hand, additional CO_2 emission is generated to deliver such goods. Another point is the space needed for storage. To meet financial and ecological benefits it is rational to rent the space at least for 33 europallets which is full capacity of typical truck from filling rate perspective.

Another implication in logistics contributing to the CE strategy is the modification of packaging. It could be changed to reduce generated waste. This solution is so needed by the environment because every company produces waste along with their finished goods. By the way, waste elimination could already start at the design stage by using biodegradable components (see Figure 3 showing an example from CocaCola). It could be a first step but not enough so companies are obligated to minimize the level of plastic, paper or wooden waste, depending on the packaging scheme. To reduce the amount of waste, companies are looking for initiatives that help them achieve this goal. For instance, Lidl decided to implement a flow pack on meat products. The retailer decided to use this solution with environmental protection in mind. Plastic has been reduced by as much as 73%, and

the packaging itself is recyclable and takes up less space in transport (Pierzchała, 2021). From the logistics management perspective, such changes implicate additional risk in the current process. Due to the modification of packaging, the pallet scheme will be changed. As a preventive action to eliminate damages during movements some trials should be conducted.

In reference to Coca-Cola's strategy in terms of packaging, introducing innovations is one of the three main pillars to execute their ambitions of creating the world without waste (website PortalSpożywczy.pl, 2021). It is packaging design, the collection of packaging and recycling, and building partnerships and a coalition for action in these areas.

An innovative solution is Keel Clip. It is paper packaging that replaces foils on multipacks of cans, which is resulting in reducing a plastic waste. It is an example of the use of biodegradable packaging components instead of plastic ones (Figure 3). The impact of this investment reflects in the reduction of the plastic the company introduces on the market by 100 tons in 2021, which is expected to double in the coming years. In addition, the energy consumption during production is reduced by 15% (Cristea, 2021). It is not only a greener and more recyclable alternative to heat-shrinkable foil, but also a functional convenience for consumers, which is the imple-mentation of the strategy of more sustainable packaging design. This solution makes full use of sustainable cardboard (FSC certified) and is designed to facilitate transport (website Portal-Spożywczy.pl, 2021).

The last section is based on a recycle process. From logistics point of view, is it possible to collect stretch film waste in order to pass it to the producer to use the waste for the production of the regranulate film. Practical issue related to this initiative is the variety of used foil by vendors. The reason to implement circular economy of foil stretch is the packaging standards for all vendors which suggest the type of foil which should be used by them. Recycling generates additional processes of reverse logistics and storage materials, which will be recycled. It is applicable especially in the case of recycling of tobacco heating equipment because some parts belong to the dangerous goods group (ADR – the European Agreement concerning the International Carriage of Dangerous Goods by Road), like batteries. Also reusing could bring financial benefits due to additional discounts in the price of used materials.

Figure 3
Keel Clip – solution from Coca Cola

Source: Cristea, 2021.

Conclusions

Implementation of CE strategies in business reality creates a significant impact on logistics operations, starting with small actions like a new way of loading trucks and ending with renting new warehouse space to store returnable items. For each change, a business case should be made to avoid additional investment without getting tangible benefits. Efficiently functioning supply chains connecting waste generation sites with waste recovery sites will allow for the construction of a profitable system, which, in the form of cooperation, collaboration or symbiosis, can be created by two or more organizations concentrating their activities in a certain area and whose goal is to use raw materials and energy more efficiently, in accordance with the principle "your waste is my raw material" (Hordyńska, 2021). The configuration of supply chains and logistics in light of the circular economy confirms that enterprises are willing to implement solutions to increase the level of circularity of their resources. The following steps can be distinguished as a starting point in terms of the revision of circularity imple-mentation within current and future supply chain. It is recommended to review current logistics processes and resources flow to address how to manage more effectively in the context of an ecological approach.

Supply chain is integrated at least within its part (the longer, the better), which means companies along the supply chain cooperate with sharing information on i.e. stock level, new products launching or incoming promotions in the long run. Mapping and rethinking current physical flows within the supply chain for each product (Stock Keeping Unit, SKU) could bring additional value from circular economy point of view. On the other hand, one can observe that the supply chain reconfiguration might take place only when the systemic approach is implemented, which means companies are able to map end-to-end their supply chains (demand networks) and therefore easily recognize and mitigate any risk that occurs in short or long distance. Nevertheless, during analysis in

the context of circular supply chain management, all potential risks should be highlighted to avoid situations where waste will be reduced and at he same time CO_2 emission will increase due to the need of organizing reverse logistics process.

The study will be continued as part of a doctoral thesis in terms of process innovations in sustainable logistics among manufacturers where circularity could be interpreted as an example of the sustainable approach.

Notes/Przypisy

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