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Specifics of Closed Loop Supply Chain Management in the food sector

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Abstract: The concept of closed-loop supply chain management is a very popular direction of research and companies' activities. It is associated with efforts like managing production residues (by-products and waste) in such a way as to minimize the level of waste transferred to landfills or incinerators. This article relates to the use of this concept in the food industry, which by its very nature, generates a lot of challenges for logistics management, also in the area of reverse flows. The article characterizes aforementioned concept and provides examples of its use in the food sector.

Introduction

The concept of sustainable development is one of the most often discussed topics in the context of enterprise and supply chain management. For many years, attempts have been made to determine the optimal combination of corporate social responsibility and sustainable business development. According to most concepts, sustainable supply chain should take into account a reverse chain, in which recycling and utilization are implemented in so called "closed loop", including operations in a traditional and reverse chain.

Caring for the environment, especially for shrinking non-renewable natural resources, has become particularly important for the world community in the last twenty years. Entrepreneurs' environmental awareness has been greatly improved, what was compounded by a number of directives aimed at tightening environmental policies of countries and international organizations. Caring for the environment began to be seen as a source of financial benefits associated with the reuse of resources and their saving. Activities related to the improvement of eco-efficiency will finally lead to the transformation of the current (brown) economy into a green economy[1].

Achievement of those objectives must be supported also by international organizations, national authorities and local government. In recent years there has been a significant intensification of work on amendments to the EU directives on waste management. A statement of the European Union published in 2014 entitled *Towards a circular economy: a zero waste programme for Europe* should have an impact on changing these directives, but its acceptance was blocked by several member states, including Poland. Subsequent attempts to change these directives will be made in 2017[2], which unfortunately will considerably delay the introduction of changes in the management of waste.

The aim of this article is to present the specifics of Closed Loop Supply Chain Management (CLSCM) implementation in the food industry. This industry generates a lot of challenges for logistics management, because in many cases includes goods with a short shelf life and expiration date. The task of logistics in this sector is not only the proper implementation of the resources flow from suppliers through manufacturers, wholesalers and retailers to the final consumer, but also the return flow, including among others production residues and unsold goods.

CLSCM concept is widely described in the scientific and professional literature. Nevertheless, there is little research about the specifics of CLSCM in the food industry. The author suspects that this is due to the huge internal differences in this industry, both in terms of products, technology and production residues. Despite this, the article attempts to universalize the approach to CLSCM in this sector, which could be a starting point for further, more detailed analyzes.

The concept of Closed Loop Supply Chain Management

The concept of Closed Loop Supply Chain Management is the result of perceiving the value of the resources that have been treated so far as waste that need to be utilized. Development of a sustain approach to supply chain management has resulted in a number of solutions, which paid attention to the environment and it is obvious that waste undoubtedly influenced it negatively. Therefore, it was necessary to find a solution for reducing waste level. Keep in mind that utilization is a process generating costs, so the waste is not constituted in traditional approaches as having potential to generate revenues but only costs. Paying attention to the ecological and economic potential, which lies in them, led to the development of reverse logistics and finally – the concept of closed loop supply chain. There is a growing importance of the materials flow from the customer (final consumer) to the manufacturer. Managers take into account the possibility of recovering value or disposal of the product. Recovered materials are a good source for material stream, which flows into the production department. This allows for closing the supply chain loop.

CLSCM takes into account the causes and consequences of activities having environmental, social and economic nature, while the traditional supply chain management typically focuses solely on economic efficiency[3]. The concept of closed-loop consists of four main areas of action: green design, green production, green distribution and waste management (see Table 1).

Achieving a state where there is no waste seems to be impossible, but there are concepts that disprove this view (e.g. *cradle-to-cradle philosophy*[4]). This is not possible without the involvement of the client in the reverse flow. A challenge for manufacturers is to convince the customer (regardless of whether it is the manager of the store, or the end user), that it is worth to return the used or unsold product to a collection point (*gatekeeping point*). This point should be located as close as possible to the customer to have to pay a low cost of delivery of the product to be recycled. It is important to remember that the customer is the recipient of a product made from recycled materials. Therefore creating the awareness of taking care of the environment gives a feedback in the form of cash twice during the life cycle of the product. Often, the very fact of taking care of the environment by the manufacturer has a positive effect on the recognition and awareness of his brand among current and potential customers. Besides, reverse logistics and the CLSCM concept grew out of market laws, and more specifically of customers' requirements[5]. Today, consumers are demanding more and more from producers of goods and services. These include: after-sales service, warranty, quick repair, replacement of a new product, obtaining a substitute model for the repair time, fast complaint handling, and finally - return of a product that did not meet their expectations. In addition, environmental requirements dictate manufacturers to continuously improve the management of resources and waste. Therefore, technological (remanufacturing) and marketing change (increase brand awareness and loyalty, improving company's image) are inevitable. [6]

Table 1.

Basic elements of CLSCM concept

Activities category	Characteristics
green design	• product design, which will enable the regeneration and re-use of the product • product design with minimal negative impact on the environment • product design with parts that can be reused in another product • designing production process so as to obtain as little residue, and if there is no possibility of reduction - so they can be used in other processes • design of product life cycle, taking into account environmental issues
green production	• use of clean technologies that do not pollute the environment or create waste products impossible to recycle and reuse
green distribution	• use of means of transport with low environmental impact • education of economical driving techniques • buying eco-efficient fleet • use of fuels with low environmental impact • establishing emission standards • implementation of improved models to predict demand in order to reduce the amount of unsold goods
waste management	• waste reduction at source (also at the end customer location) • waste collection • waste selection • transport of waste to the place of processing or disposal • pre-treatment of waste • waste sales • waste processing • cooperation with authorities and the local community • establishing emission standards and emission reduction plan • environmental education

SOURCE: own preparation with use of: M. Starostka-Patyk, *Zarządzanie łańcuchem dostaw. . .*, op. cit.,; M. Starostka-Patyk, *Logistics management of waste flows*. Second edition. Valahia University Press. Targoviste, 2012, p. 65; D. Blumberg, *Introduction to management of reverse logistics and closed loop supply chain processes*. CRC Press, Florida, USA, 2005, p. 202-204.

There are many differences in describing the concept of closed loop in the supply chain, but it is undoubtedly closely related to reverse logistics. Here can be presented two approaches: European and American[7]. Americans define closed loop as a stream of products that have been returned by a customer for various reasons[8]. Largely returns refer to full-value products, but, however the client resigned to use them. Europeans, in turn, to a greater extent focus on the reverse stream of packages[9]. So this flow consists primarily of defective, damaged products and their packaging. This is due to the fact that in Europe, much more is said about caring for the environment. The consumerism took in Europe another dimension than in America[10]. I think that in many sectors the concept of CLSCM should include both of these approaches and differentiate pro-environment activities in relation to the finished products and packaging.

Closed loop in the supply chain includes flow within a chain including four main areas of logistics activities: supply, production, distribution and reverse flow (see Fig. 1). There are several possible configurations of

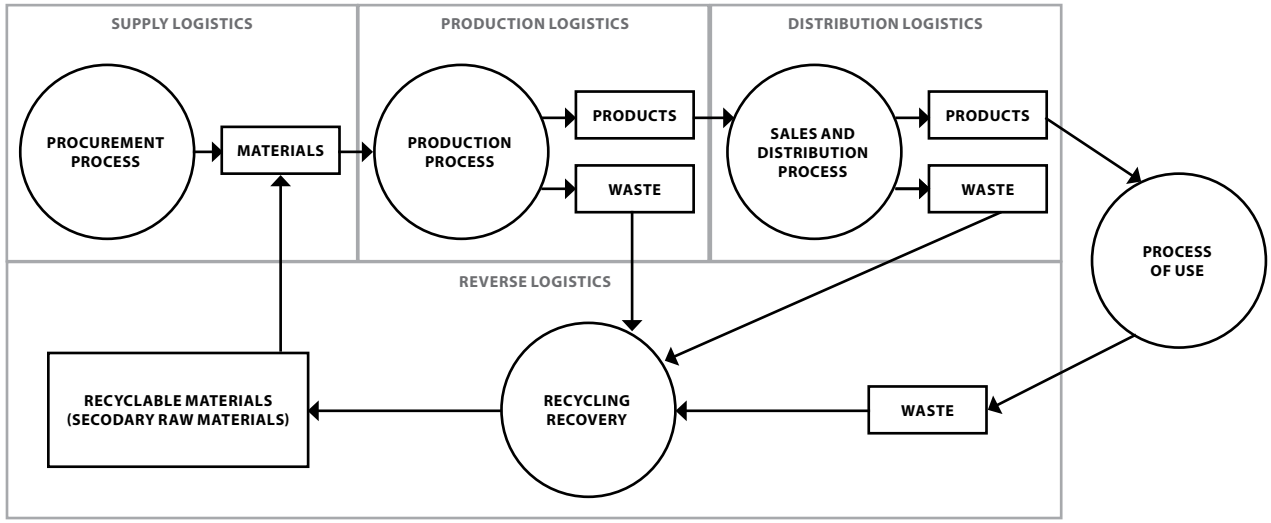

Fig. 1 Scheme of closed loop supply chain
SOURCE: own preparation.

closed-loop in the supply chain. The simpliest closed loop may include only the manufacturer (internal recycling). Then it uses the waste resulting from production processes in subsequent processes, as well as in other production processes. Slightly extended loops include two entities, eg. two producers. It is most common form of closed loop in the economy. One possibility is to provide production residues, which could be used in another company. An example might be the process of meat production. One producer company which produces meat, sausages and other processed meat products can sell production waste (eg. bones, internal organs) to another company, which will manufacture feedingstuffs or pet food. Similar cases can be found in other sub-sectors related to food. There are also closed loops, which include participants in supply chains with these from other industries. Raw materials of vegetable or animal origin can be used, eg. in the pharmaceutical or cosmetic industry (see section „The concept of CLSCM in the food sector" below). The third type of closed loop includes many participants of supply chains, including consumer of goods. Used product or its remains (in the food industry most often the remains, eg. packaging) are transferred to the producer of goods or other interested party to recover value and use up many of these resources to produce new products. This form of the loop is the most desirable, but most difficult to implement[11]. Loops take different configurations and reported cases are only simple models, which in fact may have a different form.

Decision on the destination of the product depends on the value that can be recovered from it. There are 4 stages of reverse flow:[12]

1) gatekeeping – a decision about the entry of product into reverse flow. Estimating the recoverable value/amount,
2) collecting – gathering for transmission to reverse logistics system,
3) sorting – making a decision about the further destiny,
4) disposition – sending the product to the place of destination.

Flow of goods in reverse flow in supply chain may take a centralized or decentralized form [13]. In the decentralized system decision on the future of goods is taken at the place of sale. In the centralized system, making a decision is the task of recovery center, other than the place of sale.

A very important element of CLSCM is traceability of elements flowing through the supply chain. Products, production residues, part of the products must be identified in the original chain (tracking) and in the reverse flow (tracing)[14].

The concept of CLSCM in the food sector

The food industry is internally very diverse[15]. Among the products of this branch can be distinguished products with long shelf life (eg. coffee, tea, baking powder, oil) and short one (eg. yogurts, meat, bread, vegetables, fruit). Element which binds together products in this industry is the use of organic materials in the production process, and the organic nature of the final product.

Among the features of the food industry are mentioned:

- relatively short product life cycles,
- market fragmentation (close to perfect competition) or oligopolization (depending on the considered sub-industry),
- growing customer requirements,
- growing competition,
- capital concentration.

This industry has a significant impact on environmental pollution. M.M. Nowak reported that 1/5 of the greenhouse gases is produced as a result of manufacturing and distribution of food [16]. Agricultural production (including livestock farming) in Europe contributes significantly to environment pollution, including responsibility for [17]:

- 90% ammonia compounds emission,
- 50-80% nitrogen loads discharged into freshwater,
- 10% greenhouse gas emissions (including 80% of methane emissions).

Among products of the food industry A. Tucker and B. Jensen mention beef and dairy products as those with the greatest negative impact on the environment[18].

Returns in supply chains can be divided into two groups: returns of products and of packaging. Both the first and the other can take place between partners in supply chain or between consumers and other participants in the supply chain[19]. Also the manufacturing remains flow can be joined to them (by-products and material remains; see Table 2).

Table 2.

Waste and returns in supply chains

Object	Entity making return	
	Partners in supply chain	Consumers
Products	• surplus stocks • marketing returns • products withdrawn from sale • seasonal products • damaged products • defective products • expired products	• damaged products • unwanted products • broken products • used products • warranty returns
Production remains	• byproducts • residues of materials used in the production process	-
Packaging	• returnable packaging • reusable packaging • packaging for utilization	• returnable packaging • reusable packaging • packaging for utilization

SOURCE: own preparation.

Preliminary studies of the European Commission on food waste in 2006 indicated that the sources of food waste in Europe are primarily households (42%), manufacturing companies (39%), dining facilities (14%) and wholesalers and retailers (5%)[20]. In the case of households, the causes of waste generation are too large shopping, improper storage, preparation of too large portions of food and the lack of food leftovers management. Note, however, that a large part of waste is generated by manufacturing companies and that is why in their products and processes there is a great potential for waste elimination.

Difficulties associated with the management of closed-loop supply chain in the food industry are mainly connected with the formation of large quantities of organic waste (biowaste), diversified physically and chemically. In the classical approach to closed-loop waste and used products are subject of the re-circulation. They are seen as a source of additional value. Products that have been thrown or received from the user may be, for example disassembled and recycled. However, in the case of the food industry this is often not possible due to the composition of certain products, for example yogurts and fresh vegetables. In some cases, they can be recycled and remanufactured, which results in a different product than the original one.

Table 3.

Examples of re-use of production remains in food industry

Primary production process	Production remains	Secondary production process (using production remains of primary process)	Industry of secondary process
Production of quark, cottage cheese, yogurt, cheese	• Whey, sludge from separators, clots, pieces of cheese	• Production of animal feed • Production of compost • Production of biogas • Production of industrial fuels • Production of cosmetics • Production of food supplements • Production of preservatives (eg. for the meat industry) • Production of whey beverages • Production of polyurethane foam	• Food industry • Chemical industry • Cosmetics industry • Pharmaceutical industry • Energy industry • Textile industry
Production of juices, jams, marmalades, frozen products	• Storage waste	• Production of animal feed • Production of compost	• Food industry • Chemical industry
	• Pomace (dry pulp)	• Production of fruit puree • Production of pectins • Production of animal feed • Production of spirits • Secondary production of juice • Production of wine • Production of natural pigments • Production of flavorings • Production of seed oil • Production of fruit teas	• Food industry
Production of meat	• Manure, slurry	• Production of biogas	• Chemical industry
	• Sludges from the production plants • Slaughterhouse waste	• Production of animal feed • Production of compost • Production of feed powder (meat and bone)	• Food industry
Production of sugar	• Beet pulp • Sludges from washing and cleaning • Calcium carbonate • Sugar chalk	• Production of fertilizers	• Chemical industry
Production of wine	• Pomace (dry pulp) • Musts sludges • Fermentation sludges • Decoctions	• Production of animal feed Production of fertilizers	• Food industry • Chemical industry

SOURCE: own preparation based on: K. Kozłowski, M. Cieślik, A. Smurzyńska, A. Lewicki, M. Jas, Wykorzystanie odpadów z przetwórstwa mięsnego na cele energetyczne, Nauki Inżynierskie i Technologie 2015, Vol. 16, No. 1,; http://www.nettax.pl/dzienniki/mp/2003/11/poz.159/zal1_3.2.2.6.htm, 15.06.2016; A. Fronc, A. Nawirska, Możliwości wykorzystania odpadów z przetwórstwa owoców, Ochrona środowiska 1994, Vol. 53, No. 2; M.M. Nowak, Wykorzystanie …, op. cit.

Then, in a closed loop, there are two core (production) processes that require logistical support, each in a different scope (see Table 3).

The problem of by-products and production residues management in the food industry covers a wide range of detailed problems, each of which could be the subject of separate studies. However, it should be noted that a major problem from the point of view of modern economy is the shortage of energy resources. Currently sought solutions have to enable obtaining energy from biogas, which would significantly improve the perspectives of access to energy for future generations. Increasing the energy efficiency of the economy, mainly thanks to renewable energy sources has become a priority for governments and international organizations.

Management of remains of the production process is extremely important in the realization of the CLSCM, and this concept implementation should also focus on full-value products that have not been bought by customers and must be removed from the seller's offer. For several years, there was a problem of this type of products thrown in the trash by supermarkets. This issue focuses on fresh products, which usually have a very short expiry date, such as eg. vegetables and fruit. A wide range of shops, especially these of medium and large format, often includes several thousand items in their offer, of which a large part are fresh products such as vegetables, fruits, meat, yogurts. Some studies show that in Europe 1/3 of manufactured goods in the food industry is not purchased by the customers (according to the European Commission, it is 90 million tons of food annually [21]). Polish law blocks effectively the use of expired food in the form of donations for charitable organizations and individuals or farms. Unfortunately, there are no studies that could indicate how many products withdrawn from the market could be given to those in need. Keep in mind that not every expired product loses its properties in one day, it is only exposed to their loss. E. Bożyk argues that in the case of one of retail chains monthly waste from more than 340 locations is 73 tons of food and in this area rising trend can be seen[22]. There are some draft regulations, which oblige supermarkets to free commit products to those organizations in need, which have signed the special contract. However, there is concern that the responsibility for waste will fall on these charity organizations, because not every product will find its recipient. There is a risk of a lack of adequate resources to finance eventual utilization by these organizations. Another concern is a lack of logistical and organizational preparation of these units to handle such large quantities of products.

Currently expired foodstuffs are transferred into the composting plants (70%) or incinerators (30%)[23]. There are many irregularities in handling of these waste, including gaps in waste separation and then the organic material which could be composted, is burned. This is a result of lack of interest of shop managers about waste destiny, but also a lack of legal regulations that would require positive environmental actions of stores. However, because of the prohibition of storage of materials that can be recycled (since 2025), introduction of waste management systems will become soon necessary in such organizations. Meanwhile, one of the actions to improve the situation may be environmental education, regardless of age of trained person.

Conclusions and future research guidelines

Analysis of CLSCM concept presented in the article allows to draw a single main conclusion, which relates to the food industry. Undoubtedly, this is an industry with great ecological potential, for the most part still unexploited. Shrinkage of energy resources should direct development of technologies into generating energy from biomass, and the extraction of biomass is enabled only by the food industry.

Firstly, it should be noted that CLSCM in the food industry is different than in other sectors, primarily is determined by the short shelf life of products. Activities of enterprises and supply chains should include in it flows of production residues, damaged products and packaging, as well as full-value finished products which has not been sold. However, given the nature of these products CLSCM in the food sector will be significantly different from the activities undertaken e.g. in the clothing or household appliances industry, in which a lot of returns consider full-value, non-expired goods returned by unsatisfied customers.

Also, reverse flow steps are specific to the food industry – previously mentioned four phases of movement must be carried out quickly because of the rapid loss of use value of organic materials, to a lesser extent – packaging. Traceability for such goods should be reliable, because any delay in the flow causes big economic losses. Of course, there is big variety of products marketed in the food industry – solutions in the area of CLSCM will also be very varied. Particularly problematic are fresh products, which quickly lose their value and their management should be planned very early. Unfortunately, in this area there are many gaps (also legal) to be filled.

There is a need to conduct research in the area of waste use in production of goods other than primary so as to minimize the amount of waste disposed. This should be accompanied by a series of legal solutions that will take into account simultaneously economic and environmental aspects. For example, the special role of green design is to take into account these categories even before the product is launched. The specificity of the sector can be also visible in green production and green distribution because these processes in the food industry require specific resources, are also subject to a number of laws.

If there is a rapid development of scientific research in the use of the residues, the concept of "zero wastes" will be possible to achieve. This will increase sectoral integration in the economy. The key to success is to change the current approach to the waste – treating it as a source of value

– something that can be used in other processes and thus reduce costs or something that can be sold and thus increase revenues.

There are many areas to explore in more detail in the context of CLSCM. One issue worth examining is to investigate the flow of information within the framework of such a system compared to the traditional system and to show not only the differences, but also new challenges and new solutions related to this area[24]. In addition, each of subsectors in the food industry has its own specificity that must be taken into account. It is worth therefore to carry out a number of studies related to the various sub-branches of the industry. A separate area of research can also be transportation services in the context of CLSCM and the role of the 3PL and 4PL (orchestrators of supply chains) to handle return flows. On these issues, important aspects include legal requirements, route optimization (also associated with IT support), choice of transport mode, minimizing empty runs, processing of returns and many others. It is a prove that the concept of CLSCM is an interesting and wide area of research that may lead to the development of a number of new logistics concepts.

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