SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2023
ORGANIZATION AND MANAGEMENT SERIES NO. 169

REVERSE LOGISTICS AT HOME APPLIANCE MANUFACTURERS IN EUROPE AND POLAND – CHALLENGES FACED BY THE INDUSTRY

Maciej BIELECKI

University of Lodz, Faculty of Economics and Sociology, Department of Logistics, and Innovation;
maciej.bielecki@uni.lodz.pl, ORCID: 0000-0001-6550-3512

Purpose: models of reverse logistics (RL) that consider the sustainable development goals (SDG) and circular economy activities (CEA) are increasingly appearing in the literature. Intention of the article is to show at what stage of implementation of the SDG and CEA the home appliance industry (HAI) is currently at and what challenges it faces in terms of implementing the RL model.
Design/methodology/approach: The paper shows that the information, data, industry positions and reports presented on the website of the Association of Appliance Manufacturers (APPLiA) show that the HAI is too slow in moving towards the SDG and CEA. It also prevents the implementation of theoretical models of RL.
Findings: The article shows that the current actions taken by HAI in Europe and Poland are insufficient to meet the SDG, CEA, and the implementation of full models of RL.
Research limitations/implications: The presented research results refer to the data presented by the HAI of Europe and Poland, as well as the information contained on the websites of the APPLiA Europe and Poland. The presented research results can be related to the information of other relevant industries such as automotive, aerospace and others, so that the hypothesis that the industry insufficiently pursues the SDG and CE and does not take strategic steps towards the implementation of models of RL with special consideration of all CE activities.
Practical implications: The paper points out that for the home appliance industry to realize the SDG and the CE through the implementation of RL, it must use Design for eXcellence (DfX) tools now with a focus on Design for Circular Economy (DfCE) and Design for Logistics (DfL).
Social implications: no social implication.
Originality/value: The article presents the author's model of RL and formulates challenges for the industry that are associated with its implementation. It should draw the attention of various industries to the need to take strategic actions for implementation SDG and CEA.

Keywords: Reverse Logistics, Sustainable Development Goals, Circular Economy Activities.

Category of the paper: Research paper.

1. Introduction

The dynamically changing environment, driven by technological development is itself already creating challenges for enterprises. Proposed in 2012, The Industry 4.0 strategy (I 4.0) has opened unlimited and hitherto unknown possibilities for the reality of the industrial world (Kagermann, Wahlster, Helbig, 2012). When we added, unprecedented situations such as the Covid19 pandemic or the drastically worsening state of the climate, can say, that companies in the third decade of the 21st century "are living in very interesting times". The deteriorating state of the environment is the responsibility of consumer lifestyles and especially industry, which, despite the many concepts that have appeared in recent years, continue to lag the challenges facing humankind, especially in terms of the environment.

The progressive global degradation of the environment makes it possible to hypothesize that the current business models, which are primarily profit-oriented, will have to be redefined soon. This is unlikely to be the result of the establishment of new SDG by the United Nations (UN), since, as a recent UN report shows, the achievement of the current goals is under severe threat (unstats.un.org, 2022). Among the main reasons for this are the Covid-19 pandemic, the war in Ukraine, and developing to an ever-widening extent, the climate crisis (in 2021, CO_2 emissions increased by 6%, making up more than the reduction that was achieved during the pandemic - a decrease of 5.4%) (unstats.un.org, 2022). While the issue of the Covid-19 pandemic and the war in Ukraine and other parts of the world is not related to the industry, the issue of the climate crisis is a direct consequence of its actions.

The very concept of sustainable development, very correct in its assumptions, becomes helpless when confronted with economic and economic systems, and the recommended transition from a linear economy (LE) to a circular economy (CE) (Kirchherr et al., 2017) does not have the momentum that the environment would expect. CEA, related to the issue of intelligent use and manufacturing of products (rejecting some solutions, thus some products, increasing the intensity of their use, while reducing the consumption of raw materials and materials (Refuse, Rethink, Reduce), extending the life cycle of products with its spare parts (through reuse, repair, refurbishing, remanufacturing or repurposing - Reuse, Repair, Refurbish, Remanufacture, Repurpose) to the rational use of materials using recycling and recovery, including energy recovery ending (Recycle, Recover) should become the new guidelines of every industrial sector – 10R (Potting et al., 2017).

The concept of RL appeared in the literature as early as the 1980s, the twentieth century changing its essence over the following decades to complete in its final form the phased division of logistics (procurement, production, distribution, returns and disposal). Earlier publications on the subject focused on reverse logistics processes such as transportation and warehousing in the context of reverse distribution (Tibben-Lembke, 2002). The focus then was on the issue of taking back from the market products that customers have abandoned purchasing. In the late

1990s and the beginning of the first decade of the 21st century, they began to link RL with the product life cycle. In 1998, Rogers and Tibben-Lembke defined RL as the process of managing (planning, implementing and controlling) the efficient and cost-effective flow of raw materials, finished goods and related information, from the point where the products were consumed or used, to the point of original origin of the products, in order to recover specific value or dispose of them properly - the term utilization and return logistics was then used (Rogers, Tibben-Lembke, 1998). The current shape of RL dictates a broader view of the issue, in which the process of disposal, should be a last resort. This is due to the need to incorporate into the concept of RL the aims of the Framework as well as the principles of CEA formulated within the framework of the 10R principle.

To describe idea of RL also can use the concept of Closed-Loop Supply Chain (SCCL). SCCL is an integrated system coordinating the flow of materials with the need to address diverse issues such as capacity, number, location of infrastructure facilities or coordination of the very flow of goods, materials, and raw materials through the network both towards customers and back. A considerable challenge in this case is also forecasting the demand of finished goods and the supply of products from the market. In such a model, RL has an operational character. It stands for a deliberately designed and organized arrangement for collecting materials from end users to warehouses or production centers to recover any value from the collected goods (Gholizadeh, Tajdin, Javadian, 2020). SCCL thus focus on collecting partially or wholly used products from customers and creating (or using) the value of the products themselves or their components, parts, or materials for newly created products (Guide, Li, 2010).

One of the simpler mathematical models of SCCL for disposables is presented by Krstev D., and Krstev A., They proposed supplementing the traditional logistics phases (procurement, production, distribution extended to the end customer) by forcing a reverse flow of waste products collected from the market by collection centers, which either go to the manufacturer or are recycled - Figure 1 (Krstev, D., Krstev, A., 2022).

Al-Salem et al, on the other hand, pointed out the possibility of dividing logistics into Forward Logistics and Reverse Logistics (Al-Salem, et al., 2016). Their model, shown in Figure 2, considers the stages of delivering a product to the market, reusing them, using common warehouses of different manufacturers for this purpose, ending with reverse warehouses. From both common and reverse warehouses, products go directly to factories, where they are either reused or sent to recycling processes. In their final form, disposal process takes place, as part of recovery operations recovering the energy gained from the process in the final stage.

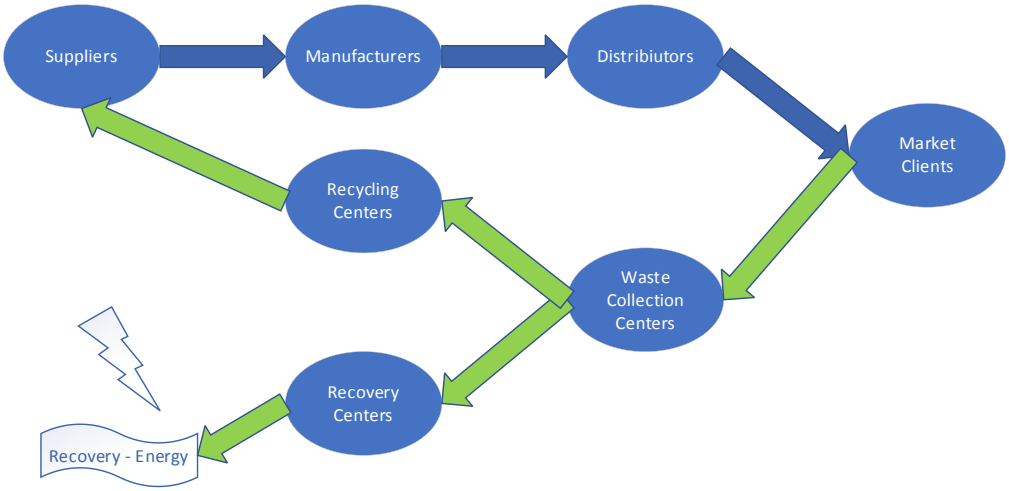

Figure 1. Closed-loop supply chain for single-use devices.

Source: own compilation based on Krstev, D., & Krstev, A. (2022). Reverse Logistics - Possibility, Expectation and Sustainability Perspectives. Natural Resources & Technology, 16(1), 3971.

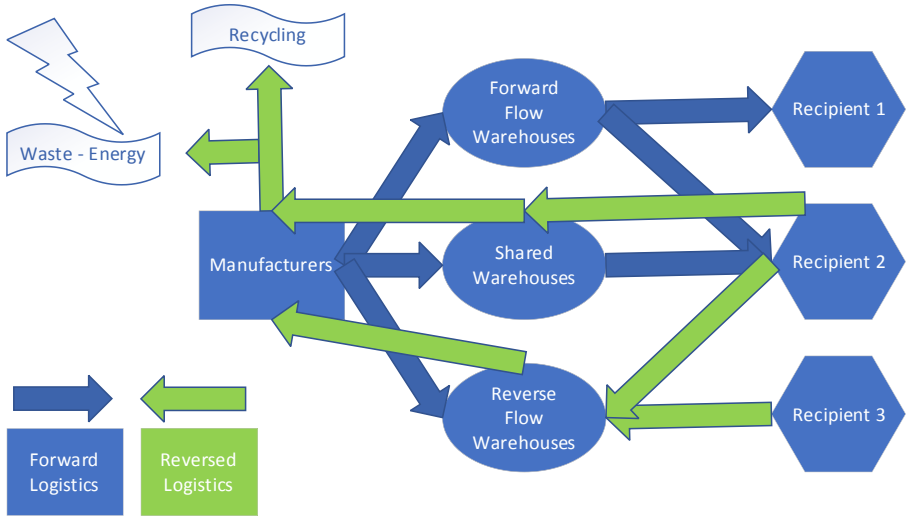

Figure 2. Closed loop supply chain network.

Source: Al-Salem, M., Diabat, A., Dalalah, D., & Alrefaei, M., (2016). A closed-loop supply chain management problem: Reformulation and piecewise linearization. Journal of Manufacturing Systems, 40, 3.

In the presented model, it is worth noting the conceptualization of "forward" and "backward" logistic. Relating this to the context of a phase-based view of logistic, in reverse logistics the phases of procurement, production (processing), distribution and returns will remain the same. Logistics in its assumptions will continue to focus on the efficient and effective flow of goods, information, cash, and others., with three basic elements changing:

1) the direction of flow (forward - backward),
2) the conditions of the processes of supply, production (processing), distribution, and returns dependent on the flows,

3) the intensity of logistics processes (transportation, warehousing, packaging including packaging, inventory management and order handling) dependent on the direction of flow and the phases that occur in them.

SCCL should therefore, like the qualitative PDCA/SDCA (Plan Do Check Act / Standardize Do Check Act) cycle (Imai, 2006), execute forward and backward flows, creating or recovering value at each stage. A side effect of these activities should be to minimize waste. The manufacturer receives raw materials and materials from suppliers, balancing waste. From final form of waste recover the energy - Figure 3.

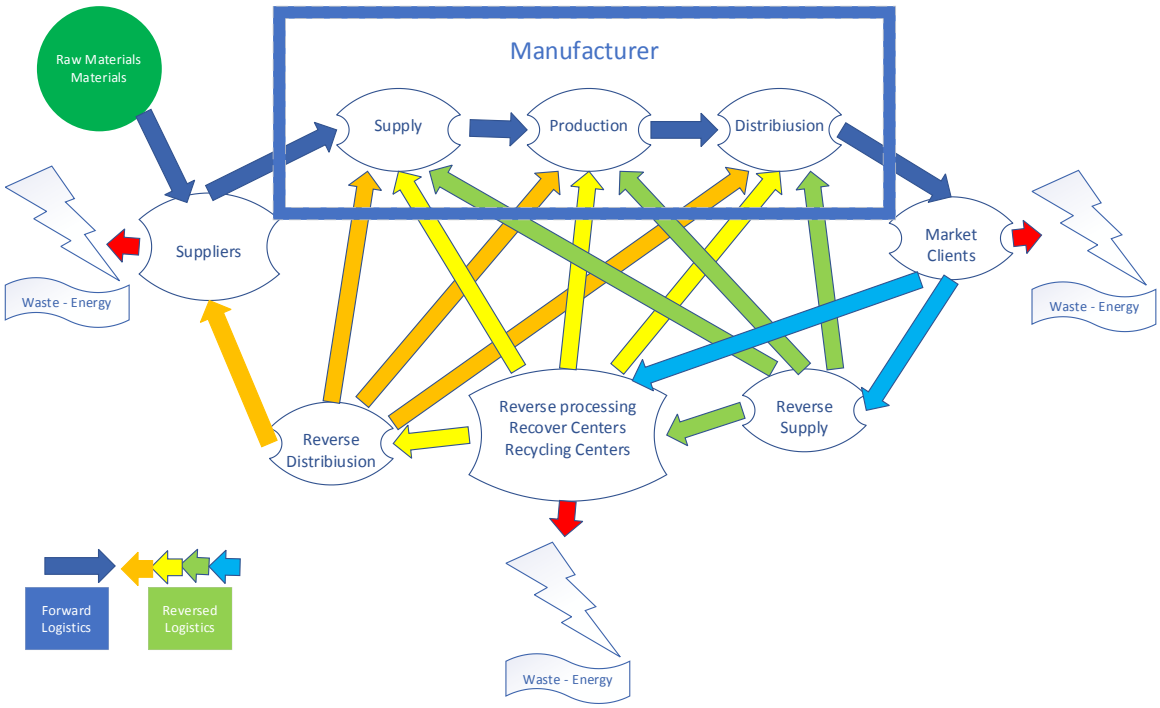

Figure 3. Closed-loop supply chain model considering forward and reverse flows.

Source: own study.

The entire SCCL system should incorporate the technological advances of I 4.0, creating logistics and supply chains at the 4.0 level - L&S.C. 4.0. Its clustered approach and gradual replenishment of materials and raw materials, can shorten the length of supply chains, making them even more resilient and resilient (Bielecki, 2022). A key element in the operation of such a model, becomes the design of products considering the use of reverse flow elements in them under the broad concept of DfX.

The SCCL or RL models presented require a variety of conditions, which include:

- creation of a unified system of identification of raw materials, materials and parts used depicting such attributes as, for example, degree of wear, origin, potential durability, and many others,
- defining take-back rules (minimum, average and maximum life cycle of products), which has a direct impact on the supply of goods taken off the market,

- initiative-taking customer behavior in used product returns (e.g., delivering products to selective take-back points, or taking apart used products and segregating materials according to Reverse Manuals, for example,
- cooperation of enterprises on standardization, modularity and multifunctionality of manufactured materials, components, and others. for their secondary use,
- standardization in product design considering the possibility of recovering specific components from the products used,
- increase involvement of countries and manufacturers (more extensively than is currently) in promote sustainable development and CE,
- regulations on the definition of new products that have used raw materials, materials, parts in them, or issues of warranty, guarantee, and others,
- and others.

It is also important to note the scale of the phenomenon and its periodization. This is because it is not possible to create a closed-loop supply chain system and implement it in a brief period. In this case, setting a roadmap for change and its consistent implementation can contribute to the realization of the goals of SDG and CEA by supply chains.

2. Method and Results

To present the scale of the phenomenon, related to the challenges of implementing the principles of SDG and CEA within RL or SCCL in HAI industry, used information from "Association of household appliance employers representing manufacturers and importers of household appliances in Europe and Poland - APPLiA EU and APPLiA PL". The choice of HAI industry was deliberate and justified by the availability of data and information within the websites of APPLiA EU and APPLiA PL.

The APLLiA association originally appeared under the name CECED Europe, was founded in 1954. In Poland, CECED was registered in 2004. In 2018, the CECED changed the name to the APLLiA. The association functioning in Poland includes 27 companies viz: Aged, Amica, Ariston, Atlantic, Beko, Biazet, BSH, Candy-Hoover, Ciarko, Daikin, De'Longhi, Dyson, Electrolux, Franke, Gorenje, Jura, Kärcher, Miele, MPM, Philips, SEB Group, Samsung, Smeg, Teka, Vestel, Vorwerk, Whirlpool to which more than 50 brands known in Poland belong (https://applia.pl/o-nas/, 2022).

For research used the APPLiA EU and APPLiA PL for the information, materials and industry reports they have. Four areas were using for aggregation of data related directly or indirectly to SDG and CEA. These areas included:

1) examination of general information (goals, ongoing projects, trends, and others.),
2) survey of press and information materials,
3) examination of industry positions,
4) examination of reports in the context of data to find the challenges facing the home appliance industry.

The first area involved the extraction of general information. The association's European website has three primary goals:

1) promoting sustainable lifestyles (appliances with resource-saving and energy-saving features that promote sustainability),
2) living in a connected home (designing connected, smart, innovative, and ultramodern appliances that improve comfort and implement sustainability guidelines),
3) accelerating Europe's economic growth (a global, free, sustainable, open, and fair-trading system) (https://www.applia-europe.eu/topics, 2022).

In each of the goals presented, APPLiA EU headquarters also mentions the need to cooperate on the issues with EU bodies with regulatory influence.

In addition to the goals, the website offers information about initiatives undertaken by APPLiA EU which include:

- ways to deal with f-gases,
- the development of compliance templates to allow suppliers to meet requirements arising from the implementation of EPREL - the European Registry for Energy Labeling,
- seeking solutions to minimize microplastic pollution,
- electricity saving tips for household appliances (https://www.applia-europe.eu/initiatives, 2022).

The Polish side of APPLiA presents three main topics:

- closed-loop economy,
- energy efficiency, and
- product safety.

On the APPLiA website, you can find a closed-loop CE model with "Circular devices" as its centerpiece - Figure 4. APPLiA's CE model starts from the stage of obtaining raw materials, through design, manufacture, use, repair to the recycling and recovery stage.

The first step is the efficient and rational use of resources and materials, which, incidentally, also follows from the basic paradigms of production management. The next phase is design that considers legal guidelines for eco-design and energy efficiency. As APPLiA EU declares, all products designed, manufactured, and delivered to the European Union (EU) market follow applicable legal requirements. During designing products, it is considering the main guidelines such as the use of raw materials and materials, energy efficiency, technological advances, and customer preferences. In the next phase, production, the aims are to reduce the environmental impact of production processes smoothly and gradually. In the use and consumption phase, the overriding goal is to deliver products to the market that minimize

energy and water consumption. The next stage is reuse after repair processes. According to statements by APPLiA EU - in 2018, more than 91% of repair requests, ended in actual repair. The recycling and recovery complete the circle, leading to the closure of the circuit (https://www.circularappliances.eu/home, 2022).

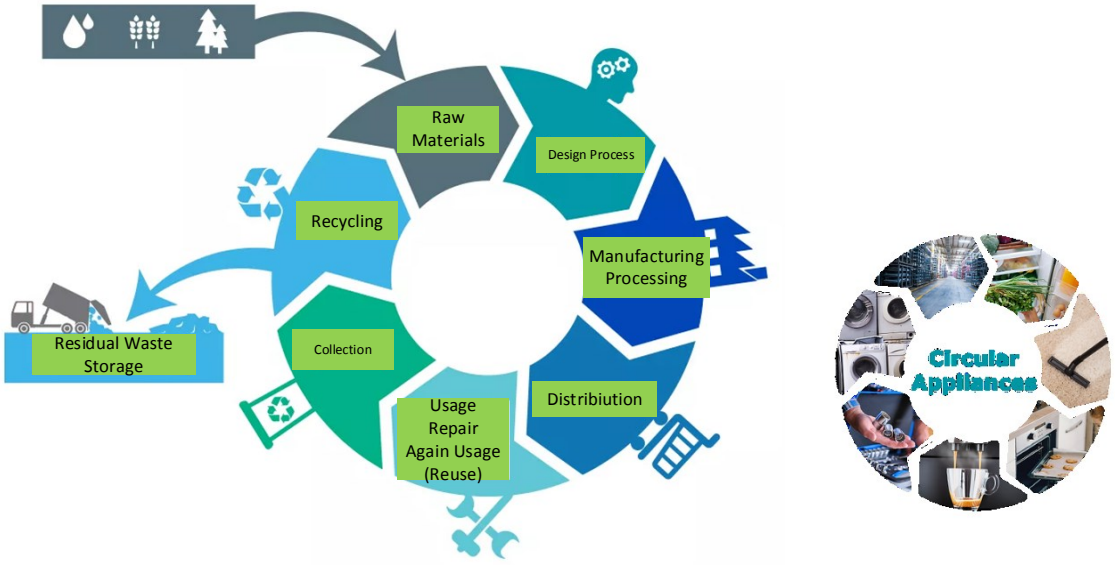

Figure 4. Closed-loop economy model according to APPLiA PL and APPLiA EU.

Source: http://applia.pl/tematy/gospodarka-obiegu-zamknietego/, 21.12.2022; https://www.circularappliances.eu/home, 23.12.2022.

On the APLLiA website, it can find specific publications which are supporting presented model. In one of them entitled "Reaching a Circular Economy: what's on the EU's plate?", Paolo Falcioni, CEO of APPLiA EU points out, among other things, the issue of legal normalization of eco-design, setting limits within CO_2 emissions (The Carbon Border Adjustment Mechanism (CBAM) - EU border price adjustment mechanism taking into account CO_2 emissions), the right to repair (understood as extending the life of products and repairing them by competent people - service), reducing F-gases and creating legal standards for batteries (https://www.applia-europe.eu/topics/, 2022).

APPLiA EU's press materials, in general, are related to the association's goals and initiatives. Recent articles from 2022 dealt with:

- APPLiA's launch of an industry-wide energy conservation campaign,
- the launch of a handbook on appliance repair,
- a report on leading the home appliance sector in the energy transition,
- information on the election of a new president of APPLiA EU,
- information on EU safeguard measures that hinder the competitiveness of EU manufacturing industry growth, and the vote of selected EU committees,
- F-gas issues in the context of competitiveness, innovation, and sustainability,
- sustainable products initiative (https://www.applia-europe.eu/ press-releases, 2022).

As for press materials, 17 press articles have been published on APPLiA PL website since the first material appeared on July 19, 2018 (https://applia.pl/media/materialy-prasowe/, 2022). Slightly more than 70% of the articles (12) have had the lack of their content on the website - only their titles were available. The largest number of press article titles concerned the issue of changing energy labels five articles (23% of all articles), which in most cases were advertising materials. Among the titles and press materials were also:

- "Opening of the year" conference materials,
- a promotional campaign for the home appliance industry educating a new generation of technicians,
- reports on industry performance,
- appeals to relevant government units on issues related to the industry's performance in the market,
- and others.

A review of the official positions of the home appliance industry in Poland dealt with issues related to sustainable development and CE in several cases. As early as February 23, 2018, APPLiA PL (then still CECED-Poland) issued a position paper on the "Roadmap for Transformation to a Closed-Circle Economy," in which it highlighted issues of extended producer responsibility for the product and sustainable consumption. It also highlighted issues of minimizing energy and water consumption. Among the topics to which the appliance industry presented specific positions were references to (starting with the oldest):

- National Energy Efficiency Action Plan 2017,
- the draft law on waste,
- the two-year transition period for eco-design and labeling requirements; and the eco-design requirements themselves and new labels for clothes dryers,
- Poland's energy policy with a time horizon of 2040,
- extended producer responsibility in waste equipment,
- processing standards in waste equipment,
- product fees for electro-recycling,
- the law on energy efficiency,
- choice of method for calculating levels,
- actively support the process of replacing obsolete electrical appliances,
- amendments to the Law on Waste,
- Eco-design and labeling action plan for 2020-2024,
- EU draft regulation on batteries,
- EU draft CBAM mechanism,
- EU framework project on eco-design of sustainable products,
- EU draft on fluorinated gases (F-gases),
- national waste management plan 2028 (https://applia.pl/media/stanowisko-branzy/, 2022).

The topics of the gave opinions on sustainability and CEA are in line with industry policies across the European Union. It was expanded to include economic and market issues. In 2021-2022, APPLiA EU addressed the following issues (starting with the oldest) related to sustainability and CEA relating to:

- battery regulation,
- sustainability strategies in the chemical area,
- regulatory approaches to sustainable product initiatives,
- F-gas regulations,
- risks arising from the EU's revision of the Eco-Design Directive,
- retrofitting old and inefficient heating and cooling systems,
- recommendations on home appliances resulting from the UN Climate Conference in Glasgow and the position on the Glasgow Accords,
- mandatory building standards to address high energy prices and achieve the EU's decarbonization goals,
- the six proposals of the Fit for fifty-five package - the emissions trading scheme, the Social Climate Fund, renewable energy, and energy efficiency directives; energy taxation and the carbon limit adjustment mechanism (CBAM),
- sorting instructions for consumers,
- standardization strategies to support digital and green transformation (https://www.applia-europe.eu/applia-media/position-papers, 2022).

The last part of the study concerned the reports presented by APPLiA. They show that energy consumption for major household products is related to space heating - Figure 4.

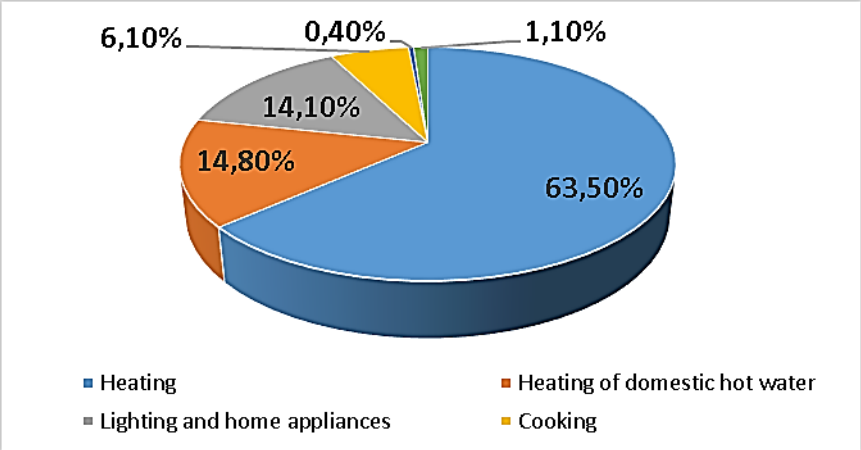

Figure 4. Household energy consumption for major household appliances.

Source: own compilation based on https://assets.website-files.com/6273d40fda4fa648b967fc54/634c73c4316ad0f573e417e0_APPLiA-Statistical-Report.pdf, p. 22, 27.12.2022.

The figure 4 presented, that space heating and water heating devices consume just under 80% of energy. This is related to the design of energy-efficient appliances, the majority of which (more than 90%) in 2020 were appliances with energy labels (A to A+++). In the same report, the industry boasts that in 2018, 91% of requests to manufacturers to repair defective appliances resulted in actual repair, with the largest repair cost for large appliances - 44% was labor, 39% was the cost of replacement parts, and 16% was the cost associated with transportation. Thus, between 2011 and 2018, the production processes managed to reduce waste by 12%, water consumption by 61% and energy consumption by 17% (https://www.applia-europe.eu/statistical-report, 2022).

The report presented the issue of circularity of material flows in the white goods industry. APPLiA EU data shows that:

- 6.3 million tons of materials entered the market,
- in EU households installed 7.9 billion appliances - 69 million tons of materials,
- 6.2 million tons of materials were placed on the market, of which 3.7 million tons of materials were recovered (https://www.applia-europe.eu/statistical-report, 2022).

It should be noted that the collection of materials is due to the law on Extended Producer Responsibility (EPR), which obliges companies to finance recycling, a minimum of 65% of the weight of equipment sold.

APPLiA PL's 2020 report shows that the number of household appliances delivered to the market in Poland is quite sizable and counted in millions of units, as shown in Figure 5.

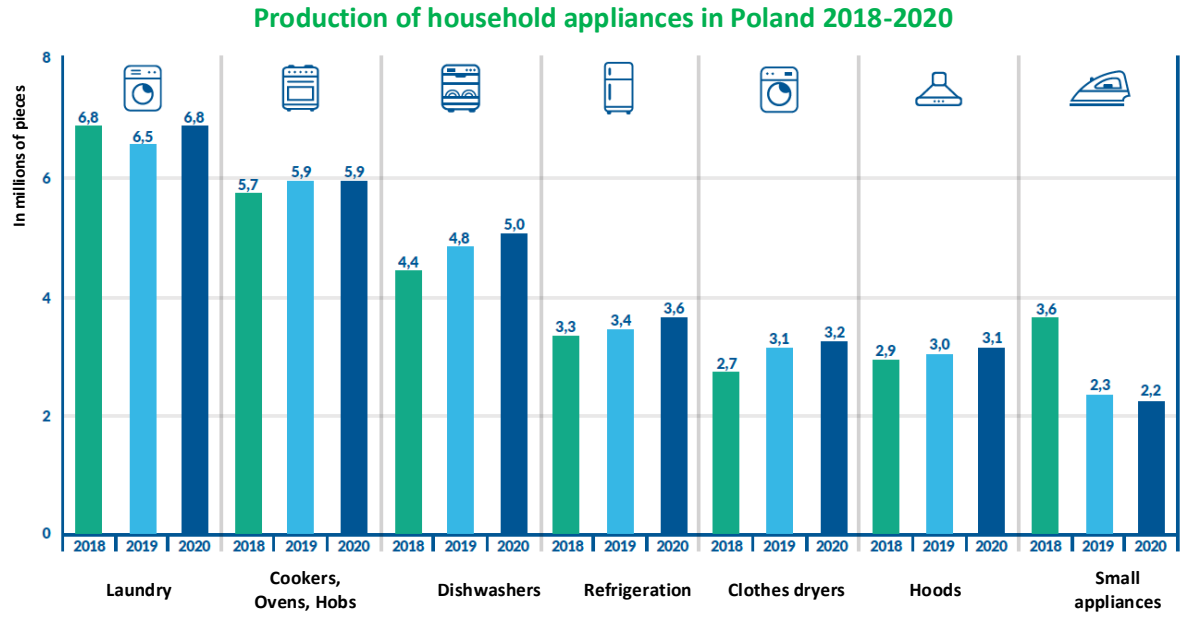

Figure 5. production of household appliances in Poland 2018-2020.

Source: APPPLiA PL, http://applia.pl/wp-content/uploads/2021/03/Applia_raport_2021_v3.pdf, p. 6, 27.12.2022.

The 2021 report shows that the level of production of household appliances in 2021, despite the pandemic and initial signs of crisis, has held up - Figure 6.

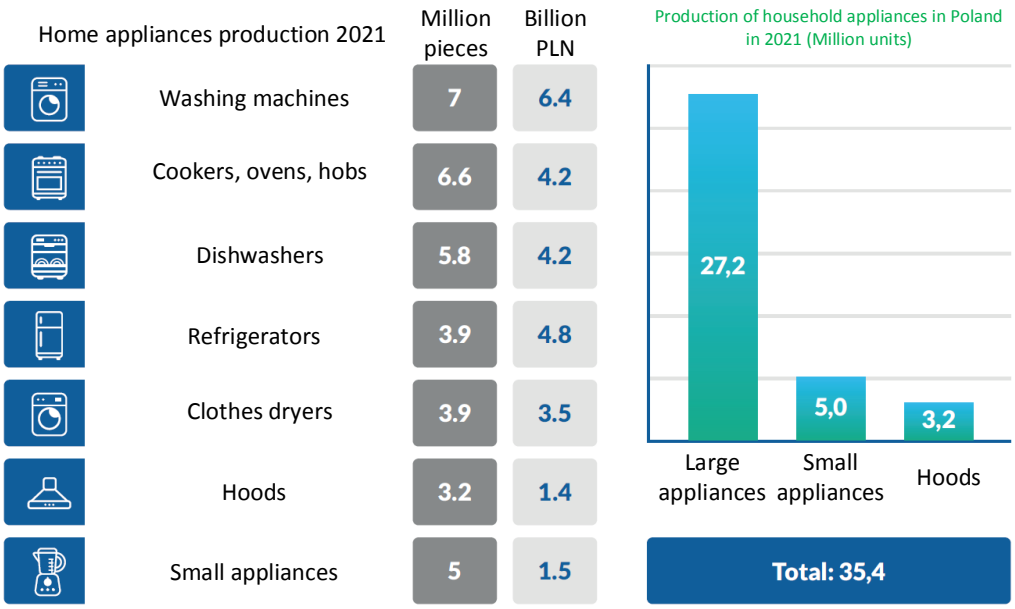

Figure 6. Production of household appliances in millions of units.

Source: http://applia.pl/wp-content/uploads/2022/09/Raport-AGD-2021.22_APPLIA-Producenci-AGD_220526.pdf, p. 8, 27.12.2022.

This means that a considerable number of household appliances are delivered to the global market each year, which, in the case of the assumptions of SDG and CEA, is quite a challenge for this industry. Now, from the data presented in the reports of the APPLiA PL association, we manage to collect 60% of waste equipment and recover slightly more than 50% of raw materials - Figure 7. The mass of collected and processed waste equipment in the white goods industry between 2010 and 2020 has quadrupled (https://www.applia-europe.eu/statistical-report, 2022).

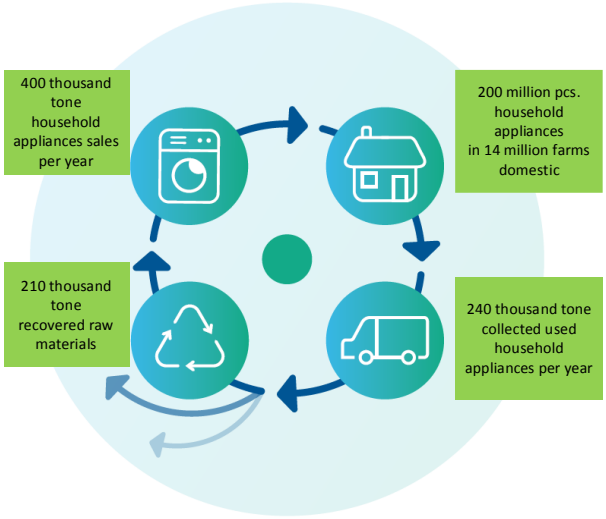

Figure 7. Production of household appliances in millions of units.

Source: http://applia.pl/wp-content/uploads/2022/09/Raport-AGD-2021.22_APPLIA-Producenci-AGD_220526.pdf, p. 13, 27.12.2022.

The measures taken by the household appliance industry related to the SDG and CEA are due to legal norms. However, in the context of such fast-moving climate change, one may try to ask whether they are sufficient, and to what extent do they fit with the selected RL models and the goals of SDG and CEA presented in the literature? At this scale of production, the challenges that the home appliance industry faces about RL are quite specific, and they will be presented in the next section of the article.

3. Reverse logistics for large household appliances - challenges facing the industry

The presented results of the study of the information materials of home appliance manufacturers supply a good basis for presenting the challenges facing the industry in the context of RL and the goals of the SDG and CEA. A good reference point for conducting such an analysis can be the model presented by Potting et al. (Potting, et al., 2017) mentioned earlier, the model of transition from LE to CE described through 10R (Refuse, Rethink, Reduce, Re-use, Repair, Refurbish, Remanufacture, Repurpose, Recycle, Recover).

If one were to attempt to analyze the materials studied in the context of the 10Rs, it can be seen that the analysis of these materials can be broken down not only into which of the aforementioned CEA are currently being used by the APPLiA industry, but also relate this to the context of the activities used - business or social - Table 1.

The previously mentioned 12% reduction in waste, 61% reduction in water consumption and 17% reduction in energy consumption in production processes certainly have their business context, bringing tangible savings to APPLiA companies. At the same point, it should be noted that the social context of these changes is already less noticeable. Of course, the implementation of new norms of energy, water consumption, and others., gives tangible benefits to consumers, but the savings in water, energy, or material consumption in production processes, do not necessarily reduce product prices, and in the author's opinion, these are insufficient measures in terms of the dynamics of climate-related changes.

Analyzing Table 1, the APPLiA industry implements only 40% of the CEA, which are core competencies of the business conducted. In the materials on APPLiA's website, it was not possible to find information on the multi-functionality of the products offered (Refuse), increasing the intensity of use (Rethink) even if only by promoting the "sharing economy", reusing products that consumers have given up - Reuse, refurbishing products - Refurbish, using products or their parts in new products fulfilling the same or separate functions - Remanufacture and Repurpose.

Table 1.
Scope of CEA of the production chain used in the APPLiA industry based on the research conducted

Economy model	Scope of CEA	CEA	Description of CEA	CEA in APPLiA industry	
				Business context	Social context
Model CE	Smart use and manufacture of products	R0 Refuse	Make a product redundant by giving up its function or finding the same function with a radically different product that is used	None	None
		R1 Rethink	Increase the intensity of use of a product (e.g., by sharing it with others)	None	None
		R2 Reduce	Increase product manufacturing efficiency and reduce consumption of raw materials and natural materials	Twelve percent reduction in waste, 61% reduction in water consumption, 17% reduction in energy consumption, reduction in fluorine gas use, reduction in microplastic pollution	Reduction in energy and water consumption of household appliances due to new standards - energy labels (A+++ to A by 2020 and A to G from 2021), reduction in fluorine gas use, reduction in microplastic pollution microplastic
	Extend the life of the product and its parts	R3 Reuse	Reuse by another consumer of a discarded product that is still in good condition and fulfills its original function	None	None
		R4 Repair	Repair and keep used products so that they can be restored to their original function	More than 91% of equipment repaired by service centers	
		R5 Refurbish	Restore an old product and update it	None	None
		R6 Remanufacture	Use discarded products or their parts in new products, performing the same functions	None	None
		R7 Repurpose	Use discarded products or their parts in new products, but in such a way that they perform distinct functions	None	None

Cont. table 2.

Model LE	Rational use of materials	R8 Recycle	Recycle Process materials to achieve the same (high grade) or lower (low grade) quality	Over 52.5% of recovered materials including batteries
		R9 Recover	Incinerate materials with energy recovery	no data available, although it is reasonable to assume that some materials go to waste incinerators

Source: own study based on J. Potting, M. Hekkert, E. Worell, A. Hanemaaijer, Circular Economy: Measuring Innovation in the Product Chain, PBL Netherlands Environmental Assessment Agency, The Hague 2017, p. 5.

A separate issue becomes the question of legislation formulated by the EU and associated countries. A number of positions that have been put forward by the APPLiA industry both in Poland and in Europe are more in the nature of lobbying for legislation rather than creating specific solutions to accelerate the fulfillment of the goals of SDG and CEA. The "When it comes to repair, #DontDespair" campaign, which promotes equipment repair, seems to be a return to practices common in the 1980s and 1990s that earlier generations took for granted. The eco-design guidelines, defined in 2009 (https://eur-lex.europa.eu/legal-content, 2022) establishing general rules for determining eco-design requirements for energy-related products, are inadequate in the context of humanity's environmental challenges. The very fact that the 2009 regulations are in place, with such a rapidly changing environment, may raise some concerns.

It is not the intention of the article's author to criticize the European white goods industry. It can be hypothesized that conducting a study of other industries, would show even more omissions or even actions against SDG and CEA (e.g., diesel gate affair of VAG group (Mazur, 2020). The article is intended to show that the issue of RL and its implementation in industrial reality for the purposes of SDG and CEA is specific challenge, and only joint action of, for example, the spheres of science and business can give tangible benefits to the environment. And the scale of the phenomenon is significant.

According to the information materials of APPLiA PL alone, seven million washing machines and 5.8 million clothes dryers will be produced in Poland in 2021 (Figure 6). If only a one-to-one assumption is made, this means that at least 12.8 million have hit the market:

- housings,
- tanks,
- drums,
- motors,
- water pumps,
- heaters and heat pumps,
- electrical harnesses, and others.

And this is only 2021, and as previous year’s show (Figure 5), the scale of production was similar.

This means that in a few or a dozen years (assuming, optimistically, such a long product life cycle), to close the circuit, we will need to collect these appliances from the market, which will be characterized by the fulfillment of far more CEA than the current (four).

If each washing machine regardless of the method of loading and dryer has minimum dimensions in cm (depth/width/height) of 60x40x80, which is about 0.192 m3, then with such a scale of production, about 2,500,000 m3 of appliances will have to be taken from the market, having an idea of how they can be managed. If we assume that a standard curtain-sided trailer has a volume of 91 m3, (internal length 13.68 m, width 2.48 m and height 2.7 m (https://www.dsv.com/pl-pl/, 2022), this means almost 27,500 trailers receiving used equipment, which then needs to be stored (depending on the cubic capacity of the warehouse, the values here may vary), and then recycled or recovered in a specific way, taking the final form of CEA. And we are talking here only about washing machines and dryers, leaving out such products from large household appliances as refrigerators, ovens, or gas stoves. The calculation also omits all small household appliances, the volume of which, due to their size and price, is also a concrete contribution to the overall phenomenon.

From the point of view of the facts presented, for any industry and the business models used today, RL is becoming a costly undertaking requiring multidisciplinary cooperation of the scientific and business spheres. The organization of the RL network itself (order handling of returned products, their transportation and storage along with packaging and wrapping, management of used product inventory) opens an interesting field for conceptual discussion on a model view of RL.

However, an even greater challenge is facing the sphere of product design, which, using DfX concept, must increasingly consider issues of Design for Sustainable Development (DfS), Design for Circular Economy (DfCL) or Design for Closed Loop Supply Chain (DfSCCL). This raises a number of questions, among others from the following areas:

- market (e.g., will customers want to buy products that would use used raw materials, materials, or components in some part; will they want to use old products for other functions, and others.),
- legal (e.g., how the issue of warranty for these products is to be managed, what is the manufacturer's responsibility in this regard; how to harmonize the law globally, and others.),
- operational (e.g., how to consider in now design products, the need to use certain components in the future; what number of components will be usable; how to control the quality of used parts; how RL systems are to be built, and others.),
- geopolitical (how these systems are to work on a global scale, whether agreement is possible across all divisions and interests, and others.),
- and others.

Certainly, in current business models, these questions in many cases seem meaningless and pointless. Considering such convoluted questions in times of economic crises or the challenges that have confronted the global economy because of the Covid19 pandemic or the war in Ukraine is already enough of a problem. It seems, however, that sooner rather than later the climate will raise the same questions in an accelerated formula, and then we will have to deal with corrective rather than preventive measures, which in the theory of management science and quality (especially quality) are far less effective.

4. Summary

As presented in the article, the issue of RL has many critical points that complicate the effectiveness of its implementation. Assuming the full realization of SDG17 - Partnerships for the Goals: helping the whole world develop by enabling effective cooperation and communication between countries (http://www.unic.un.org.pl, 2022), the very issue of building an efficient and effective RL system is very complicated and complex. Transparency and climate cooperation are increasingly appearing in public speeches, becoming a fashionable and catchy topic. Unfortunately, the response to these topics, which for the moment is proposed by the industry together with the economies of specific areas of the world, seems to be far from sufficient.

The example of home appliance manufacturers in Europe is not an isolated one, and in the article was used only to illustrate the current activities of one of many industries. The research shows that the APPLiA association clearly emphasizes concern for the environment, presents a number of actions taken, but against the background of current challenges and opportunities, certainly public expectations are much higher. In conclusion, it should be emphasized that those of the companies or industries that are the first to embark on the difficult road of redefining current business models in favor of real (rather than apparent) solutions to climate problems, using RL that realize the goals of UR and CEA, will ultimately benefit, contributing to the protection of life on Earth.

References

1. Abdelshafie, A., Fatouh, T., Rashid, M. (2021). Trends and Practices of Reverse Logistics in Electronic Industry: A Case Study of Samsung Company. *Global Business & Management Research, 13(3)*.

2. Al-Refaie, A., Kokash, T. (2022). Optimization of sustainable reverse logistics network with multi-objectives under uncertainty. *Journal of Remanufacturing*.
3. Al-Salem, M., Diabat, A., Dalalah, D., Alrefaei, M. (2016). A closed-loop supply chain management problem: Reformulation and piecewise linearization. *Journal of Manufacturing Systems, 40.*
4. Bielecki M., (2022). Total Logistics Management, Logistyka i łańcuchy dostaw 4.0, Lodz University Press, Lodz.
5. Che, A., Lei, J., Jiang, Z. (2022). Optimised redesign of reverse logistics network with multi-level capacity choices for household appliances. *International Journal of Production Research, 60(18)*.
6. Condeixa, L.D., Silva, P., Moah, D., Farias, B., Leiras, A. (2022). Evaluating cost impacts on reverse logistics using an Economic Order Quantity (EOQ) model with environmental and social considerations. *Central European Journal of Operations Research, 30(3).*
7. Gholizadeh, H., Tajdin, A., Javadian, N. (2020). A closed-loop supply chain robust optimization for disposable appliances. *Neural computing and applications, 32(8).*
8. Guide, Jr., V.D.R., Li, J. (2010). The Potential for Cannibalization of New Products Sales by Remanufactured Products. *Decision Sciences, 41*.
9. http://applia.pl/tematy/gospodarka-obiegu-zamknietego/, 21.12.2022.
10. http://applia.pl/wp-content/uploads/2021/03/Applia_raport_2021_v3.pdf, accessed 27.12.2022.
11. http://applia.pl/wp-content/uploads/2022/09/Raport-AGD-2021.22_APPLIA-Producenci-AGD_220526.pdf, accessed 29.12.2022.
12. http://www.unic.un.org.pl/files/164/Agenda%202030_pl_2016_ostateczna.pdf, accessed 28.12.2022.
13. https://applia.pl/.
14. https://applia.pl/media/materialy-prasowe/, 22.12.2022.
15. https://applia.pl/media/stanowisko-branzy/, 27.12.0222.
16. https://applia-europe.eu/.
17. https://applia-europe.eu/applia-media/position-papers, 27.12.2022.
18. https://assets.website-files.com/6273d40fda4fa648b967fc54/634c73c4316ad0f573e417e0_APPLiA-Statistical-Report.pdf, 27.12.2022.
19. https://eur-lex.europa.eu/legal-content/PL/TXT/PDF/?uri=CELEX:32009L0125&from=ES, 28.12.2022.
20. https://unstats.un.org/sdgs/report/2022/The-Sustainable-Development-Goals-Report-2022.pdf, 20.12.2022.
21. https://www.applia-europe.eu/initiatives, 22.12.2022.
22. https://www.circularappliances.eu/home, 23.12.2022.
23. https://www.dsv.com/pl-pl/nasze-rozwiazania/rodzaje-transportu/transport-drogowy/wymiary-naczep/naczepa-kurtynowa, 27.12.2022.

24. Imai, M. (2006). Gemba Kaizen. Zdroworozsądkowe, niskokosztowe podejście do zarządzania, MT Biznes, Warszawa.
25. Kagermann, H., Wahlster, W., Helbig, J. (Eds.) (2013). *Securing The future of German Manufacturing Industry. Recommendation for implementing the strategic initiative Industry 4.0. Final report of the Industrie 4.0.* Franfurkt/Main: Working Group, German Academy of Science and Engineering.
26. Kirchherr, J., Reike, D., Hekkert, M. (2017). Conceptualizing The Circular Economy: An Analysis of 114 Definitions. *Resources, Conservation and Recycling, vol. 127*.
27. Krstev, D., Krstev, A. (2022). Reverse Logistics – Possibility, Expectation and Sustainability Perspectives. *Natural Resources & Technology, 16(1).*
28. Kwok, H.L., Yiming, W. (2009). Reverse logistics in the electronic industry of China: a case study. *Supply Chain Management: An International Journal, 14/6*.
29. Lu, Y., Lu, J., Jia, H. (2011). Study on the Environmental Cost-sharing Method for Reverse Logistics in Household Appliances. *Energy Procedia, 5*.
30. Mazur, Z. (2020). Dieselgate i konsekwencje prawne manipulowania emisją spalin. *Internetowy Kwartalnik Antymonopolowy i Regulacyjny, nr 7(9).* Uniwersytet Warszawski.
31. Melo, A.C.S., de Lucena Nunes, D.R., Júnior, A.E.B., Brandão, R., de Menezes Nascimento Nagata, V., Martins, V.W.B. (2022). Analysis of activities that make up reverse logistics processes: proposition of a conceptual framework. *Brazilian Journal of Operations & Production Management, 19(2)*.
32. Pacheco, E.D., Kubota, F I., Yamakawa, E.K., Paladini, E.P., Campos, L.M.S., Cauchick-Miguel, P.A. (2018). Reverse logistics: Improvements and benefits when shifting parts exchanging process in a household appliance organization. *Benchmarking: An International Journal, 25(5).*
33. Potting, J., Hekkert, M., Worell, E., Hanemaaijer, A. (2017). Circular Economy: Measuring Innovation in the Product Chain. The Hague: PBL Netherlands Environmental Assessment Agency.
34. Rodrigues Vaz, C., Grabot, B., Houé, R., Uriona Maldonado, M., Selig, P.M., Taboada Rodriguez, C.M. (2015). Theoretical model of intellectual capital for the reverse logistics post-sale process: Case of Refrigeration Appliances. *Perspectivas Contemporâneas, 10(2).*
35. Rogers, D.S., Tibben-Lembke, R.S. (1998). *Going Backwards: Reverse Logistics Trends and Practices Going Backwards: Reverse Logistics Trends and Practices, Logistics Management*.
36. Yildirir, S.C., Sayan, Z. (2022). An Evaluation of Reverse Logistics Applications from Consumer Perspective. *Dogus University Journal, 23(2).*