

DOI: 10.55505/sa.2023.1.11
UDC: 658.567:664(495+479.25)



STIMULATING CIRCULAR ECONOMY IN THE FOOD INDUSTRY: A COMPARATIVE ANALYSIS OF THE GOVERNANCE STRATEGIES IN GREECE AND ARMENIA

Davit MARKOSYAN^{1*}, ORCID: 0000-0002-3388-9366,
Vardan ALEKSANYAN², ORCID: 0000-0002-1352-0086

¹Armenian National Agrarian University; /Panteion University of Social and Political Sciences, Armenia

²Department of Management and Business Administration, Yerevan State University, Armenia

*Author for corresponding: Davit MARKOSYAN – e-mail: davitzmarkosyan@gmail.com

Abstract. The success of transformation to a circular economic model mainly depends on effective government interventions. The objective of this paper is to reveal the implementation schemes, actors in charge, and funding mechanisms of the circular economy action plan in Greece. Additionally, a comparison has been made concerning the waste management governance practices in Armenia given a few distinct political, social, economic and behavioral characteristics common to both countries. Special emphasis was put on the food industry, since it generates a large amount of waste annually with limited by-product valorization and recycling rate. A comprehensive document analysis has been conducted with deductive or concept-driven approach using the software Atlas.ti. Research results highlighted several deficiencies existing within the policy papers and a set of recommendations covering critical success factors such as education, finance, cooperation, market development, monitoring, and evaluation related to the system change were offered. By addressing these deficiencies, policymakers may ensure an environment conducive to circularity practices and facilitate the transition to a more sustainable and resource-efficient economy.

Key words: circular economy; governance; action plan; document analysis; waste management; food industry.

INTRODUCTION

Under the global economic and environmental crisis, conventional production in almost all sectors needs to be replaced with a more sustainable and resource-efficient system (Dufrou et al., 2012). Particularly, the one-way trip of production to consumption, also known as the cradle-to-grave economy, can threaten the natural capital of our planet causing massive disruptions of the ecosystem. This, in return, affects different layers of our life aspects (McDonough and Braungart, 2010). The newly emerged concept of Cradle-to-Cradle economy relies on design thinking and change in the entire system of production. From the perspective of the food industry, this practice stimulates the cycle of nutrients known as “biological metabolism” (Braungart et al., 2007). “Cradle-to-Cradle” and “Circular Economy” (CE) as newly developed concepts are perceived as interchangeable, and they are sometimes identified with sustainability. Though similar to their long-term visions, circular economy and sustainability have a few distinctions. Circularity focuses on value retention, while sustainability is a broader concept and it ensures the intersection and balance of social, economic, and environmental factors. If presented graphically, it can have the visual interpretation of Figure 1 (adapted from Walker et al., 2022.). As can be noted, there are two frameworks that have been men-

tioned in the circle: R-Framework and System Thinking (Kirchherr, 2017).

In practice and in the literature, there are various R-Frameworks elaborated. The most common one and essentially the first was the 3-R Framework, which stands for Reduce-Reuse-Recycle (Kopacek, 2021). Those frameworks have been updated and upgraded over time. Nowadays, even the 10-R framework can be found in the literature and white papers developed by different international organizations. The European Union has officially adopted the 4R framework: Reduce-Reuse-Recycle-Recover. Those actions are the key elements to making transformation in the production system. System thinking, however, refers to a change that happens at micro, macro, and meso-level (Vanhamaki et al., 2019). Transformation at a macro-level happens due to the structural change in the entire economy. Meso-level refers to eco-industrial parks and collaboration between the economic entities. Change attributed to individual players or companies in the economy is defined as micro-level approach (Robinson, 2022). Circular Economy is thinking that not only emphasizes the “less is good” strategy but also restores and regenerates the resource base (Garcés-Ayerbe et al., 2019). However, shifting to CE is not merely the responsibility of the direct players such as businesses. The government has a very important role in terms of establishing regulatory frameworks and designing policies (Circularity Gap Report, 2021).

The research visit to Panteion University in Athens influenced the selection of the circular economy action plan in Greece for comparison. The firsthand knowledge and understanding of a country’s culture, history, and socio-political dynamics served as the cornerstone for this research study.

Thus, the main objective of the study is to identify the regulatory and policy frameworks and actions in Greece and briefly compare them with those from Armenia focusing on the food industry, where applicable.

The research questions proceeding from the main objective are the following:

RQ1: What are the key findings and insights from the analysis of the circular economy action plan in Greece: scope, measures and implementation schemes?

RQ2: What recommendations can be made to enhance its effectiveness and address any identified limitations or gaps?

RQ3: To what extent does the current waste management system in the Republic of Armenia support the transition towards a circular economy?

MATERIALS AND METHODS

As a review paper of a regulatory and policy frameworks of Greece and Armenia, this paper used various sources of information such as EU acts, policy papers and national strategies. On the one side, the actual regulatory and policy frameworks were screened out, on the other side, already existing white papers from international organizations, reports, scientific papers, and book chapters as analyses of the frameworks were extracted from Google Scholar, Scopus, Springer, and Web of Science databases. To get maximum corresponding search results from those databases, special search operators have been applied with particular keywords. Among them “Circular AND “Econo-

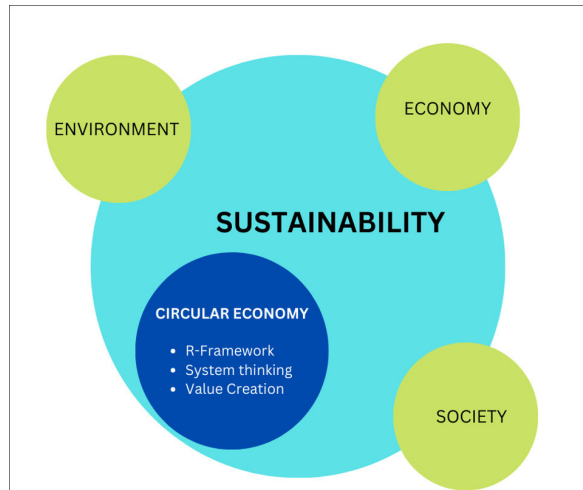


Figure 1. Sustainability VS Circular Economy (adapted from Walker, A.M. et al 2022.)

my” AND “Food” and “Policy” were mostly used. To get comprehensive results, different parts of the texts were selected: Title, Abstracts, and Keywords through capitalizing only the first letter in words. Full-texts were not used within the search phase, as it could result in a number of papers that covered general information on those notions.

Journal articles, policy, and regulatory frameworks, white papers, and other types of literature were analyzed using Atlas.Ti, which is a computer-assisted software for qualitative, quantitative, and mixed research methods. Deductive or concept-driven and inductive coding have been used for the purpose of this analysis¹. It is based on the ground theory or individual research questions. Here the researchers have a pre-defined set of codes and they assign excerpts to codes while reading the documents. Inductive coding is an approach to conduct literature review, where the researcher derives codes (themes, concepts, etc.), while screening the documents.

The final list of the concepts for deductive approach:

CE Definition by the national strategy and their objective

- Environmental
- Social
- Economic

Priority areas

Vision: time and statement

Barriers to CE implementation

Interventions

Implementation Process in Food Industry

- Consumer Agency
- Market Development
- Finance/Funding
- Technology and Infrastructure
- Participatory approach
- other arenas

Actors

Monitoring and Assessment

RESULTS AND DISCUSSIONS

Current State of Circularity in Greece

EU member countries upon establishing their national action plans, also report their circular economy indicators. This enables many actors in the transformation to make data driven decisions.

Four major circular economy directions are specified in the Eurostat, where the circular economy-related data is provided by the member countries: production and consumption, waste management, innovations, and competitiveness as well as secondary raw materials. Each category has a specific set of indicators for each country. Before discussing on the circular economy action plan as a policy approach toward change, there have been made a few comparisons between Greece and EU averages in terms of their indicators².

According to Eurostat, Greece’s circularity rate was 3.4% in 2020, which is lower than the European Union (EU) average -11.7%. Although the waste recovery in the Greek National Action Plan of Circular Economy plays a vital role, the level of circularity in the country is still very low. Collecting, sorting, and treating waste may significantly impact

¹ <https://dovetail.com/>

² All the indicators that are described in this paper are taken from the Directorate-General of the European Commission (EUROSTAT) with the latest access on the 18th of April, 2023.

the circularity rate in the country, while the development of circular business models may guarantee quick and efficient transformations.

According to the Environmental Implementation Review carried out by the EU Commission in 2017, 81% of its municipal waste in Greece is sent to landfills (compared to the EU-28 average - 31%), while only 16% is recycled (EU-28: 27%) and 4% is composted (EU-28: 15%).

Management of food waste may ensure many benefits for the environment, economy, and society.

Europe is experiencing a significant amount of food waste, however, and Greece has larger food waste per capita (191kg) than the EU average (131kg) (Eurostat, 2023).

According to the European Parliamentary Research Service, the 120 Mtonnes of EU food waste causes 170 Mtonnes of CO2 emissions and eventually, it consumes 261 Mtonnes of resources.

Food waste is not only a matter of ethical and environmental concerns, but it is also about a huge loss of monetary value: it is calculated that \$940 billion USD a year is being lost due to food waste globally (Uekert et al., 2020).

In Greece, food waste is generated by almost all the elements of the food life-cycle: in agricultural primary production, processing, retail, and at household consumption. Therefore, wasting food at any stage of its life cycle means wasting all the resources used from the „farm-to-fork” pathway.

Food production and waste are also associated with extreme pressure and stress on the energy-land-water nexus as scarce resources (EU Fusions, 2023).

In the past decade, Greece has developed many regulatory frameworks and policies for food waste prevention and utilization. One of the most prominent action plans in Greece is the National Strategic Waste Prevention Programme (NSWP), which is based on many other policy papers and legal documents (Sakalis, 2023). The mix of the Greece policies on the food waste management is provided in Figure 2.

NSWP has a few major objectives, which cover a wide range of sectors. The major objectives of the NSWP are raising public awareness and improving public information programs on of waste prevention, promoting sustainable consumption of products, and product reuse.

Food Waste Prevention and Management is also separately addressed among all the sectors that NSWP covers. The NWPP has set a strategic objective to achieve a 30% decrease in food waste per person by 2030, as compared to the amount of food waste generated in 2022 by both consumers and retailers. This objective includes reducing food waste in primary production, processing and manufacturing, retail, restaurants, and food services, as well as in households. The aim is to reduce food losses along the production and supply chain. This provision has been included in Article 20, paragraph 2, of Law 4819/2021, which implements Directive 2018/851 at the national level. Additionally, a dedicated program for preventing food waste is being developed and will be completed soon.



Figure 2. Greek policy Mix of Food Waste Management (Source: <https://www.eu-fusions.org>)

Last but not the least, it is important to pay special attention to the employment opportunities created by the circular economy. The number of individuals employed is described as the overall number of people working in the observed entity, such as a company.

Overall, the number of people in the EU employed in a circular economy was around 4,3 million in 2021. In Greece, 60 thousand people were employed in the circular economy in 2021.

In conclusion, we can state that transition towards circular economy in Greece has been fostered in recent years. Although most of the circular economy indicators are low compared to the EU average, the tendency is positive. A number of waste management practices have been proposed by the public authorities through special policy packages including prevention, reuse, recycling, and energy recover.

Analysis of Circular Economy Action Plan (CEAP) in Greece

Circular Economy has a pivotal role in EU policy frameworks (Garces-Ayerbe et al., 2019). In 2005, the term “decoupling” for resource use was already present in EU policy papers. In 2011, the roadmap towards a resource-efficient European economy has been established, which aimed to transform the conventional economy towards a sustainable system by 2050. In 2015, the EU published the Circular Economy Action Plan (CEAP 2020), which was updated in 2020. The core essence and slogan of this policy document are to build a “cleaner and competitive Europe”. This should be implemented through the prism of the following categories as mentioned in the CEAP 2020: sustainable production, empowered consumers, enhanced lifetime of products, and less waste. The CEAP has identified and included the following high-impact sectors: Electronics and ICT, Batteries and Vehicles, Packaging, Plastics, Textiles, Construction and Buildings, Food and Water. Since 2015, EU countries have also adopted distinct national strategies for Circular Economy. In this paper, the Greek national strategies have been explored.

This action plan is considered an official document issued by the Greek public authorities. “National Circular Economy Strategy” in Greece was adopted in December 2018 by the Ministry of Environment and Energy. Greek public authorities have identified the need for industry transformation due to the country’s limited resources and specific geographical aspects. The enablers of the smooth transition are described by the availability of untapped secondary resources and waste, scientific workforce, and know-how. The national action plan defines the circular economy as a model based on rational resource use, the concept of recycling and reuse, and industrial symbiosis (Hellenic Ministry of Environment and Energy, 2020). Three-dimensional advantages of the circular economy have been provided in the action plan, which are summarized in the table below.

Table 1. *Economic, environmental, and social benefits of circular economy (elaborated by the authors through deductive coding)*

Economic	Environmental	Social
reinforced primary and secondary economic sectors, economic specialization, high-added value, reduced dependency on imports, improved trade balance, improved resource and energy productivity indices, development of small and medium enterprises	rational waste management, reuse of water, greenhouse gas emissions and pollution reduction, green public procurement	higher levels of employment, development of social economy, youth engagement, new knowledge, technology, and vocational skills, decreased brain drain, innovative ways of consumption

The national action plan of the country provides a number of incentives and priority areas for the modernization and implementation of CE practices. Waste management and eco-design are seen as key aspects for CE within the set priority areas of the country, among them are food waste management, public and private construction, water efficiency, energy, development of renewables, and urban mobility. The action plan by public authorities is central to the circular economy discipline, as it consists of the set of implementation tools.

Financing is one of the distinct measures of the CE policies in Greece, which includes the development and support of demonstrative CE models, enterprises, and technological advancement. Smart financing tools have a specific role in the funding dimension of the policy. The use of funds through the financing institutions such as the Investment Bank, the Juncker Package, and the National Strategic Reference Frameworks (NSRF) is considered an efficient measure to the benefit of CE development in Greece.

When it comes to market development, the Greek public authorities emphasize the role of developing the market of secondary raw materials: special focus is given to textile and food products. The action plan embraces the development of the entrepreneurial mindset in the country by developing new products, business models, technologies, and forms of organization. Overall support and promotion of new entrepreneurial models regarding environmental innovation are highlighted by the development of new products, technologies, and forms of organization. Market models based on leasing/hiring, sharing, repairing, upgrading, and recycling are included in the strategic development of the circular economy in Greece.

Implementation of circular practices in the Greek economy is also envisioned by the development of technologies and infrastructure. The Greek public authorities have given a special focus on them. The action plan ascertains that there should be more policies designed to develop 'smart factory' concept, that will use innovative technology with green, modular, and digitalized elements. Under a comprehensive economic reformation plan, Greece has also integrated the plan of innovative applications and cutting-edge technology for waste management. It is noteworthy that the agrifood sector represents another thematic direction of the reform.

The action plan has been primarily motivated by the collaborative efforts of multiple agencies towards transformation. Greek authorities have introduced a public dialogue on the operational plan of the circular economy. Social organizations, as well as citizens, participated in the consultation services through meetings, conferences, and letters, as well as through Open Government (OpenGov) platforms to share their opinions and recommendations on the potential improvements.

Additionally, within the scope of Action 1.19, Greece incentivizes the use of agricultural and industrial waste by the Energy Communities through the participation of local authorities, local agencies, and citizens in energy communities.

The monitoring and audit of the circular economy transition have been specifically discussed in the action plan by the Secretariat, which is an Inter-Ministerial Coordination body.

The role and responsibilities of the Secretariat include setting the timeline and monitoring the schedule, defining the circular indicators, and following up their implementation. Quantifying the effectiveness of the actions is also a part of the responsibilities of the Secretariat.

Shortcomings and Barriers of the action plan

Although the Greek National Plan on CE is well elaborated and has big coverage in terms of the functioning areas and industries, there are some delays in its implementation and there are many actions that have not been completed. According to the authorized Climate Change and Sustainability Services practice of Ernst & Young (HELLAS) Certified Auditors Accountants S.A. ("EY"), there have been one or two years of delays in the implementation of some predefined targets. Due to these delays and failures to meet the overall target of Directives, Greece has faced legal issues in the Court of Justice of the European Union. It is noteworthy that more than 50% of the directives mentioned above are related to the circular economy.

Moreover, the sectors included in the CE action plan are mostly transitional, which are characterized by the waste management. These sectors usually have lower value circular practices such as recovery and/or recycling.

Specifically, the transitional phase mostly includes low-value waste treatment strategies such as recycling or recovering. In some linear sectors, the waste is still entirely disposed.

As for the Greek Food and Beverage sector, local authorities, due to the collaboration with Hellenic Recovery Recycling Corporation, collect the mixed waste. The food bio-waste in Greece originates mostly from the consumption phase, however, the majority of the waste is landfilled and only 19% is recovered. The recovered bio-waste is being used either as a resource for the same industry or used as animal food. Those gaps in the implementation may be the result of the lack of proper monitoring and audit mechanisms, enforcement of laws, and the absence of administrative fines.

There are, however, many other factors hindering the transformation towards a circular economy in Greece. Awareness degree of the circular economy producers is very low at this stage. They have not enough knowledge and experience related to the circular practices and principles as well as to the benefits these may bring to their activities. Thus, the action plan should play a critical role in addressing this issue through awareness raising among producers, as well as among other actors in the market. Another barrier is the lack of financial support, incentives, and general funding for the enterprises to produce in a resource-efficient manner. Limited expertise, lack of technology, and infrastructure are also hindering the smooth transformation toward the circular economy. Many Greek organizations try to recycle or recover the waste; however, it is imperative to work on the product design too. According to Den Hollander et al. (2017), designers should aim to make sure that the materials of the products can be recycled efficiently, and can be recovered in the economic closed loop.

Comparison with Armenia

Within the past decade, Armenia faces many environmental issues as well. The overexploitation and unsustainable use of natural resources, pollution, poor management of water resources, forestry, and waste have made the country vulnerable to many health and economic hazards.

However, unlike many EU member states, Armenia has not designed a national action plan for the circular economy, therefore, for the purpose of this study we will make a general comparison with the Waste Governance in Armenia. Overall mechanisms, actors, and technological and infrastructure availability will be presented highlighting food waste as a separate category in the existing sectors.

According to the waste governance report of Armenia, the overall understanding and implementation of waste reduction, sorting, recycling habits, and customs is very limited in the country (Amirkhanian A. et al, 2020). In addition, solid municipal

waste management by corresponding authorities is not implemented properly leading to many social and environmental hazards. The waste management action plan is not monitored properly, thus many works have been left unfinished (Alpetyan et al., 2020).

The 2019 Government Program Action Plan emphasizes the role of waste management in various sectors like industry, agriculture, healthcare, and construction. However, it is vital to adopt a cross-sectoral approach to waste management by integrating waste-related policies and strategies into other policies and national action plans to make the process more comprehensive and participatory in other sectors as well. Nonetheless, it is noteworthy that the action plan does not propose economic incentives for sustainable resource management and the circular economy has never been mentioned (Alpetyan et al., 2020).

Another action plan that addresses directly waste management is the “2017-2036 Municipal Solid Waste Management System Development Strategy” (MNP, 2017), which aims to propose a system that corresponds to EU standards. Two major quantitative objectives of the action plan are collecting (95%) and sorting up to 20% of the waste generated in Armenia. Sorting the waste, however, is way below the Greek recycling rate at 24.6% and 47% of the EU average in 2019. This action plan also does not address the management of biological waste, which has a great potential in Armenia in terms of waste management hierarchy.

The Sustainable Agricultural Development Strategy for 2010-2020 also did not address the agricultural waste management, even though the potential for the application of residues from agricultural operations is large in Armenia, especially for the purpose of bioenergy generation (MOA, 2010).

There are some other action plans, laws, and policies in Armenia, that address the waste management issue such as the “Cleaner Production Concept”, “Extended producer responsibility (EPR)”, and the Comprehensive and Enhanced Partnership Agreement (CEPA) between EU and Armenia.

In conclusion, the following drawbacks can be noticed about the Waste Management strategies in Armenia (Alpetyan et al., 2020):

- In the laws and regulations of Armenia, the Waste Hierarchy (WH) is not defined, which results in vague definitions, as well as lost economic opportunities;
- An absence of monitoring and evaluation among collecting and dumpsite operators
- Lack of facilities to treat hazardous waste and no legal act to enforce their construction;
- No clear definitions of some sorts of waste such as bio-waste in the legal and regulatory documents;
- Lack of waste segregation.

Funding has a crucial role in improving waste management strategies in any country. Due to targeted financial schemes, public authorities can ensure infrastructure development, construction of better facilities, as well as proper research and data availability. The following financial shortcoming can be noted in the waste governance of Armenia (Amirkhanyan A. et al, 2020):

- ◆ low fees for waste management;
- ◆ low environmental taxes;
- ◆ Lack of proper pricing for waste management operations;
- ◆ Loss of added-value from recycling and waste recovery.

Unfortunately, there are many drawbacks of the infrastructure development in Armenia too. For example, there is no separate infrastructure to collect food waste, which eventually ends up in landfills without any control measures. Some agricultural residues and organic waste are treated to some extent; however, the volumes are very low.

Overall, food waste management in Armenia is still not functioning in a sustainable manner due to the lack of infrastructure, and technology, as well as to the lack of its address in the regulatory and policy frameworks of Armenia. Even though some rare cases can be found in Armenia, when biological and food waste is used for energy purposes, landfilling is the major treatment causing Greenhouse gas (GHG) emissions.

CONCLUSIONS AND RECOMMENDATIONS

The analysis of the action plan for circular economy in Greece shows that the country has initiated major steps to ensure its successful transition and management.

Public authorities have chosen priority areas that require system change to transition from a linear to a circular economy. Agrifood industry is included in the list of sectors, however, the suggestions for change remain very generic and not explicit. Waste management, eco-design and the use of renewable energy are the key elements mentioned as drivers for circularity. The Ministry of Environment and Energy highlights the participatory approach among various actors, which is one of the key strengths of the national action plan. The ongoing public dialogues among citizens, companies and other non-governmental organizations are highly beneficial for smoother and efficient transition. The importance of financial mechanisms, market development and technological development are well elaborated. However, actually, Greek public authorities have encountered many issues related to the implementation process.

Table 2. Recommended improvements for each of the components described

Educational Component	<ul style="list-style-type: none"> a. Introducing educational programs in schools and universities that cover the concepts of circular economy, its management and role for environment, society and economy. b. Designing training and other capacity building programs for professionals who work as business managers, waste management professionals, food processors and engineers, designers. c. Establishing a network between successful private circular companies and a wide range of public representatives to share knowledge and experience. d. Providing more funding for NGOs to conduct non-formal educational campaigns about circular economy for professionals, as well as for those, who are generally interested in. e. Fostering youth exchange programs between countries which have a well-established circular business environment.
Financial Component	<ul style="list-style-type: none"> a. Setting up a separate fund for circular economy projects in close collaboration with financial institutions, NGOs, as well as public with authorities. b. Offering tax incentives, subsidies and other attractive packages for businesses to consider transformation from linearity to circularity. c. Improving the start-up ecosystem, encouraging incubation and acceleration programs, which highlight the role of circular projects and ensuring proper funding for their implementation. d. Introducing green and circular public procurement processes especially related to food industry and catering in public institutions such as kindergartens, hospitals, elderly houses, etc.
Monitoring and Evaluation Component	<ul style="list-style-type: none"> a. Developing a central monitoring system in the country, which will track the circularity transition. b. Reviewing the indicators and targets, if necessary, introducing new measures that will improve the quantification of circularity transitions. c. Establishing a special research and development group, which will track the data related to circular economy and make proper in-depth analysis on the needs and gaps for smoother transitions.

Participatory Component	<ul style="list-style-type: none"> a. Introducing and creating an ecosystem, where participatory approach is highly valued among public authorities, enterprises, NGOs and consumers. b. Promoting the development of collaborative digital platforms, where multiple stakeholders may build partnership, have easy access to information, knowledge and even share materials. c. Establishing an international partnership for sharing expertise especially with those, who are frontrunners in circular economy transition.
Market Development Component	<ul style="list-style-type: none"> a. Fostering demand for circular products through consumers' awareness. b. Promoting a collaborative network and eco-industrial parks between the representatives of supply chain to access the waste materials, residuals, to share knowledge and common infrastructure. c. Promoting the establishment of recycling centers, collection and sorting facilities, and composting sites.

On the other hand, Armenia still does not have an action plan for circular economy and government authorities, businesses, as well as public have a low-level of awareness of this concept. The lack of public policies, infrastructure and technology, as well as of financial resources hinder the development of circularity in the Republic of Armenia. Thus, the adoption comprehensive policy measures towards the system change in Armenia should be the first step. Although there is a waste management governance in Armenia, it does not address circular economy in strategies and actions given its broader essence. Unfortunately, the country is still behind when it comes to sustainable and cost-effective solutions for managing waste, including food waste.

The drawbacks, which need to be pinpointed here, are failures of meeting the predefined deadlines, quantifiable targets, appropriate monitoring and evaluation. The lack of capacity building for diverse stakeholders are shortcomings both in Greece and Armenia. The level of awareness and education among consumers, producers and even public authorities, which are responsible for policy making remain low, affecting the development of circular economy in the country.

Based on this study, a set of recommendations may be proposed to Greek and Armenian public authorities who are responsible for change management from linearity to circularity:

REFERENCES

1. ALPETYAN, H., NALBANDYAN, L., GEGHAMYAN, O., AVETYAN, N. (2020). A report on waste governance in Armenia, March 2020, Yerevan, Armenia, 203 p.
2. BRAUNGART, M., MCDONOUGH, W., BOLLINGER, A. (2007). Cradle-to-cradle design: creating healthy emissions - a strategy for eco-effective product and system design. In: Journal of cleaner production, vol. 15(13-14), pp.1337-1348. Available: <http://doi.org/10.1016/j.jclepro.2006.08.003>.
3. Circularity Gap Reporting Initiative. „Circularity gap report 2021.” (2021).
4. DEN HOLLANDER, M.C., BAKKER, C.A., HULTINK, E.J. (2017). Product design in a circular economy: Development of a typology of key concepts and terms. In: Journal of Industrial Ecology, vol. 21(3), pp. 517-525. Available: <http://doi.org/10.1111/jiec.12610>.
5. DUFLOU, J. R., SUTHERLAND, J. W., DORNFELD, D., HERRMANN, C., JESWIET, J., KARA, S., HAUSCHILD, M., KELLENS, K. (2012). Towards energy and resource efficient manufacturing: A processes and systems approach. In: CIRP Annals, vol. 61(2), pp. 587-609. Available: <http://doi.org/10.1016/j.cirp.2012.05.002>.
6. EUROSTAT (2023). Data Browser [online] [viewed 17.04.2023]. Available: <https://ec.europa.eu/eurostat/databrowser/explore/all/economy?lang=en&display=list&sort=category>.
7. FAO. FAO in Armenia, © FAO, 2023. Available: <https://www.fao.org/armenia/fao-in-armenia/armenia-at-a-glance/ru/>

8. GARCES-AYERBE, C., RIVERA-TORRES, P., SUAREZ-PERALES, I., LEYVA-DE LA HIZ, D.I. (2019). Is it possible to change from a linear to a circular economy? An overview of opportunities and barriers for European small and medium-sized enterprise companies. In: *International journal of environmental research and public health*, vol. 16(5), p. 851. Available: <http://doi.org/10.3390/ijerph16050851>
9. KIRCHHERR, J., REIKE, D., HEKKERT, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. In: *Resources, conservation and recycling*, vol. 127, pp. 221-232. Available: <http://doi.org/10.1016/j.resconrec.2017.09.005>
10. KOPACEK, P. (2021). Automatized Disassembly a Tool for saving the Environment. In: *IFAC-PapersOn-Line*, vol. 54(13), pp. 408-412. Available: <http://doi.org/10.1016/j.ifacol.2021.10.482>
11. MCDONOUGH, W., BRAUNGART, M. (2003). Towards a sustaining architecture for the 21st century: the promise of cradle-to-cradle design. In: *Industry and environment*, vol. 26(2), pp. 13-16.
12. MCDONOUGH, W., BRAUNGART, M. (2010). *Cradle to cradle: Remaking the way we make things*. North point press, 193 p.
13. MNP: "2017-2036 Municipal Solid Waste Management System Development Strategy".
14. MOA: "2010-2020 Sustainable Agricultural Development Strategy of the Republic of Armenia." <https://faolex.fao.org/docs/pdf/arm190701.pdf>.
15. Hellenic Ministry of Environment and Energy. (2020). National Action Plan for Circular Economy in Greece. Retrieved from https://www.minenv.gr/wp-content/uploads/2020/06/NAP_Final_30_06_2020.pdf.
16. ROBINSON, S. (2022). A systems thinking perspective for the circular economy: chapter 3. In: *Circular Economy and Sustainability*, vol. 1: Management and policy, pp. 35-52. Available: <https://doi.org/10.1016/B978-0-12-819817-9.00034-X>.
17. SAKALIS, A. (2023). Waste Management in Greece: A Herculean Task. Available: <https://waste-management-world.com/artikel/waste-management-in-greece-a-herculean-task>
18. UEKERT, T., DORCHIES, F., PICHLER, C. M., REISNER, E. (2020). Photoreforming of food waste into value-added products over visible-light-absorbing catalysts. In: *Green Chemistry*, vol. 22(10), pp. 3262-3271.
19. VANHAMAKI, S., MEDKOVA, K., MALAMAKIS, A., KONTOGIANNI, S., MARISOVA, E., DELLAGO, D.H., MOUSIOPOULOS, N. (2019). Bio-based circular economy in European national and regional strategies. In: *International Journal of Sustainable Development and Planning*, vol. 14(1), pp. 31-43.
20. WALKER, A.M., OPFERKUCH, K., ROOS LINDGREEN, E., RAGGI, A., SIMBOLI, A., VERMEULEN, W.J., CAEIRO, S., SALOMONE, R. (2022). What is the relation between circular economy and sustainability? Answers from frontrunner companies engaged with circular economy practices. In: *Circular Economy and Sustainability*, vol. 2(2), pp. 731-758.

Conflict of interests

The authors declare that they have no conflict of interests.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Paper history

Received 8 May 2023; Accepted 12 June 2023

© 2023 by the author(s). This is an open access article distributed under the Creative Commons Attribution License (CC BY 4.0).