

CIRCULAR ECONOMY AND SUSTAINABLE DEVELOPMENT: THE CASE OF GREEK ISLAND MUNICIPALITIES

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Abstract

The environmental degradation, the excessive use of natural resources, the climate crisis as well as the social and economic inequalities are among the major threats facing the planet and asking for immediate action. The prevailing linear production and consumption model seems unable to provide the required solutions to these problems and hence the use of an alternative model, that of circular economy, may offer a better way of addressing those issues. The present paper exposes the new trends in circular economy models, outlines their basic principles and highlights the potential benefits but also the possible pitfalls stemming from their application. On a second level, it focuses on the Greek island municipalities and presents the main findings of relevant research which has been carried out. The research employed quantitative methods, utilizing a questionnaire distributed to Greece's island municipalities, sixteen of which participated in the study. These municipalities are characterized by distinct features regarding their size, degree of isolation and other geographic specificities. The research collected and analyzed the views of elected

officials and members of administrative staff regarding their extent of familiarity with the concept of the circular economy, the current level of implementation of circular policies in their municipalities, the main barriers faced, the main strategies required to overcome them and further promote circular policies and finally, the perceived benefits arising from the adoption of circular practices.

This paper contributes to the existing literature by providing a targeted empirical analysis of circular economy (CE) integration within the unique context of Greek island municipalities. It provides localized empirical evidence on how principles and practices of circular economy are filtered through the unique geographical and administrative constraints of insular regions.

Keywords: Circular economy, sustainable development, Greek island municipalities, circular practices, circular models

1. Introduction

The contemporary global landscape, characterized by escalating environmental degradation and the multifaceted impacts of climate change, renders the reassessment of dominant developmental patterns imperative. Despite the mobilization observed over the last three decades—marked by pivotal milestones such as the United Nations Conference on Environment and Development in Rio (1992) and the subsequent Kyoto Protocol—the international community remains confronted with a developmental and environmental impasse.

Within this context, there is an increasing convergence among political leadership, the business sector, the academic community and the civil society, regarding the necessity of transitioning toward a new production paradigm. The circular economy (CE) model emerges as a critical instrument in this direction, as it incorporates functional

characteristics capable of substantially supporting sustainable development goals on a global scale.

The present study focuses on investigating the degree of penetration and implementation of circular policies in Greek island municipalities, emphasizing their distinct geographical characteristics and other inherent particularities. Through quantitative research conducted among representatives of 16 insular municipalities (including both elected officials and administrative staff), this paper attempts to delineate the level of awareness, existing practices, and perceived benefits of circularity. Furthermore, it examines the critical barriers encountered and proposes strategic directions for the promotion of circular policies. The research findings highlight significant drawbacks in the implementation process; but at the same time identify the circular economy as a field of growing interest and priority for local government.

This research offers a novel perspective by treating Greek islands as closed systems to evaluate the implementation gap between high conceptual awareness and low technical familiarity among local authorities. It uniquely contextualizes these barriers within the centralized and paternalistic structure of the Greek state.

2. The Circular Economy as a Driver for Sustainable Development

Since the mid-2010s and following the initiative of the United Nations to promote the 2030 Agenda and its 17 Sustainable Development Goals (SDGs), co-signed by 193 countries (UN, 2025 a), an overall acceptance and common perception of sustainable development at the global level has been observed, primarily, however, as a general principle. Regrettably, this has not been reflected, so far, on the level of practices or substantive priorities among governments worldwide. Indeed, according to the latest UN report (UN, 2025 b), *"amid intensifying climate change, geopolitical tensions,*

economic shocks and increasing fragility, progress on the Goals is falling far short of the scale or speed needed." The priority assigned to achieving sustainability goals is determined by varying criteria for each country, such as the level of development, cultural and social specificities, and often the urgency of immediate decision-making due to the impacts caused by natural phenomena.

Within this framework, the issue of how, how quickly, and by what means sustainable development matters can be substantially advanced globally is particularly complex.

Data from the OECD (2025) indicates that the circular economy has yet to transition from a marginal practice to a dominant economic model. Within the European Union, the sector's contribution to GDP remains stagnant at approximately 2%. Furthermore, the 2023 circular material use rate of 12% reveals a significant implementation gap, as it represents only half of the 24% target set by the 2020 Circular Economy Action Plan. This stagnation stems from the failure of several Member States to comply with mandatory waste management regulations. On a subnational scale, the challenge is equally pronounced, with only 13% of large OECD regions successfully aligning with Sustainable Development Goal 12 (SDG 12) regarding responsible production and consumption.

In the recent literature (Kirchherr et al. 2017; Geissdoerfer et al., 2017), sustainable development is considered as a broader objective, for the achievement of which circular economy constitutes a necessary practical tool. A pivotal element in shaping their relationship is the decoupling of the economic growth from the consumption of finite resources. Circular economy offers the appropriate mechanisms, practices, and business models for doing that. This is accomplished through both the minimization of resource inputs and the function of closed loops for resource renewal via processes such as recycling, reuse, and remanufacturing.

The circular economy model constitutes a core pillar of global sustainability strategies and has triggered high expectations in the vast majority of stakeholders as a potential solution to the problems caused by the linear economic model (take-make-dispose). However, its adoption and application differ from case to case.

The concept of the Circular Economy is encountered in contemporary literature as early as the 1960s, notably in the works of Kenneth Boulding, who, observing the problems of pollution and resource depletion, referred early on to the notion of circularity, related solutions, and the need for more durable goods (Boulding, 1966). Several researchers emphasize the contribution of environmental economists Pearce and Turner a few years later (Pearce & Turner 1990). Nevertheless, in recent decades, the interest in the implementation of circular economy has intensified at the political, academic, business, and social levels, fostering significant expectations for an economic model better suited to the challenges faced by modern societies.

Circular economy requires organizations to rethink their supply chains and business models. Several frameworks found in the academic and practitioners' literature propose circular economy business models (CEBMs) to redefine how organizations create value while adhering to circular economy principles.

Building on original industrial ecology thinking, circular economy has recently been re-popularized as both a public policy and business concept (Ellen MacArthur Foundation 2012). At national level, European countries and China in particular, are trying to adopt circular economy principles as guidelines for the envisioned redesign of their economies, which requires changes in the macro-level (cities, provinces, regions, and nations), mid-level (networks, eco-industrial parks), and micro-level (individual companies, consumers).

Circular economy may be defined as “a regenerative system in which resource input and waste, emission and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling” (Geissdoerfer et al. 2018). Circular economy may not be a final goal, but rather part of an ongoing process to secure greater resource efficiency and effectiveness. While we have achieved advances in some aspects of circular economy, such as recycling in various sectors and countries as well as increasing energy efficiencies, activities and concepts such as remanufacturing, sufficiency, and slowing consumption are less widespread.

Circular economy is defined as a system that strives to be regenerative and restorative while reducing the speed of waste generation. Economic development can be also realized in conjunction with environmental sustainability. Furthermore, circular economy aims to provide a framework and possibilities for economic growth in a way that reduces environmental impacts and the use of finite resource consumption by improving the quality and maintaining the value of materials, components, and products or reusing them over and over again (Oghazi and Mostaghel, 2018).

According to Ellen MacArthur Foundation (2025) three are the main features of circular economy: eliminate waste and pollution, circulate products and materials at their highest value and regenerate nature.

The importance of implementing practices for product and material circularity is recognized as a strategic opportunity to improve industry efficiency, secure supply chains, benefit communities, and create jobs (US Department of Energy, 2024). This may be achieved through:

- Minimizing environmental life cycle impacts of manufactured products.

- Reducing the burden on local communities from material extraction and processing.
- Increasing supply chain security and resilience.
- Strengthening domestic manufacturing and creating good jobs.
- Leading in the development and commercialization of end-of-life processing technologies.

To effectively integrate circular economy, organizations must undergo a strategic re-evaluation of their supply network; this, in turn, dictates a comprehensive redesign of the value creation and delivery processes inherent in their business models (Wells and Seitz 2005).

A pivotal element throughout this transition towards circularity is the extent to which organizations, commonly considered circular, adopt the corresponding business models. According to the OECD (2019), these models can be classified into the following categories

- Circular supply: Replacing raw material inputs with sustainable options.
- Product life extension: Prolonging the use period of existing products.
- Sharing economy: Facilitating collective and intensive use of products.
- Product service systems: Selling functions and services rather than products.
- Resource recovery: Recycling waste into secondary raw materials.

By examining the emerging global conditions and analyzing the principles of the circular economy, it becomes evident that the adoption of this model can provide viable solutions to the current crisis. From an environmental perspective, it contributes to the reduction of air, water, and soil pollution, as well as the saving of natural resources, while supporting efforts to mitigate climate change. According to the Circularity Gap Report 2019, 62% of global greenhouse gas emissions are generated during the manufacturing phase (PACE, 2019). The implementation of

circular economy models could reduce these emissions by 48%, by 2030 and 83% by 2050 (Ellen MacArthur Foundation et al., 2015).

Concurrently, it is essential to highlight the economic stimulation resulting from the adoption of circular practices. According to Ellen MacArthur et al. (2015), European GDP could experience an increase of 11% by 2030 and 27% by 2050. Furthermore, a significant advantage lies in the reduced dependency on raw material imports, as materials are continuously cycled back into production. This transition enhances the trade balance and renders the economy less vulnerable to the frequent price volatility of raw materials or potential supply chain disruptions. According to the European Environment Agency Report (2016), material imports in the European Union could decrease by up to 24% by 2030, resulting in annual savings of €600 million. At the microeconomic level, individual firms stand to benefit from reduced production and operational costs. These benefits can be further amplified through industrial symbiosis, where the waste or by-products of one company serve as raw materials for another. Within this framework, the emergence of new business opportunities and investment prospects becomes quite possible.

Significant opportunities also emerge within the labor market; it is for instance estimated that 120,000 jobs could be created in the EU through the recycling of organic waste and its conversion into bio-based fertilizers (European Commission, 2016). Simultaneously, circular practices foster employment growth in other sectors, such as sustainable agriculture and renewable energy sources. Considering the aforementioned factors, it is reasonably argued that such a model creates the necessary conditions in order to contribute to the alleviation of global poverty (Cervantes Puma et al, 2024).

Despite the aforementioned positive prospects arising from the adoption of the circular economy, according to the European Environment Agency (2024) most of the European countries continue to operate under a predominantly linear model, where products placed on the market tend to have a relatively short use phase. Business models primarily revolve around mass-producing products, often sacrificing quality, and this results in early breakdown or premature obsolescence.

A critical factor for the transition toward a circular model is the engagement of all stakeholders, ranging from governments to individual citizens. Among these actors, the role of cities is considered pivotal in promoting sustainable development policies—and particularly circular strategies—the significance of which is analyzed in the following section.

3. The Role of Circular Economy in Sustainable Urban Transformation

Circular economy is increasingly emerging as a transformative socio-economic paradigm aimed at optimizing resource efficiency. Within the context of cities and regions, this model gains heightened significance as global megatrends—including climate change, demographic shifts, and rapid urbanization—restructure the production, distribution, and consumption of goods and services. Conceptually, circularity necessitates the reintegration of resources into environmental and economic cycles, minimizing material dissipation through systematic reuse and waste prevention. Such a transition is facilitated by a multi-dimensional approach, spanning from innovative product design to the promotion of pro-environmental behavioral patterns (OECD, 2019).

Urban centers serve as the primary engines of the global economy, generating 85% of global GDP; however, this economic output comes with a significant environmental footprint. Cities are responsible for 75% of worldwide natural resources consumption

and account for half of the global waste production. Furthermore, they are major contributors to climate change, emitting between 60% and 80% of the total greenhouse gases (Ellen MacArthur, 2025). According to EEA (2024), household consumption volumes in the EU increased sharply between 2000 and 2019. Volumes increased by as much as 47% for household goods and services (household equipment, appliances and ICT) and 43% for services (health, education, finance, recreation and other).

As highlighted by the Hellenic Agency for Local Development and Local Government (2020), the high concentration of productive activities and consumption patterns within urban centers results in intensified flows of materials, energy, and, inevitably, waste. Effectively managing these inflows and outflows represents a critical and often formidable challenge for municipal authorities; however, it remains a fundamental prerequisite for the implementation of circular economy. Local government possessed the strategic capacity to establish regulatory frameworks, foster the necessary enabling conditions, and raise public awareness, thereby substantially amplifying the impact of circular initiatives

According to Ellen MacArthur Foundation (2017) municipal authorities are pivotal in fostering urban environments that are prosperous, sustainable, and inherently restorative by design. This crucial function stems from their intimate connection to the daily realities of residents and businesses, coupled with the policy tools available to them. Local administrations are confronted with, and actively mitigate, the detrimental effects of the prevailing 'extract-produce-discard' linear model. These costs manifest as substantial public expenditure on waste disposal, financial burdens from systemic inefficiencies, such as underused infrastructure, economic losses due to

traffic gridlock and public health issues arising from atmospheric and acoustic contamination.

While urban centers bear the brunt of the linear economy's shortcomings, they simultaneously serve as the main engines for progress. Municipalities possess the power to trigger expansive, systemic shifts and their leadership in championing this transformation has noticeably strengthened in recent times.

Cities and regions can impact decisively towards circular transition. First, they hold core responsibilities in key sectors for circular economy such as transport and solid waste. Second, they are laboratories for innovation and experimentation. Third, being responsible for 60% of public investment in OECD countries, sub-national governments can lean on critical long-term investment choices related to energy, transport and water (OECD, 2020). Hence, they can avoid linear lock-in for infrastructures. Cities can be promoters, facilitators and enablers of the circular economy.

By integrating the principles of circular economy into urban policy frameworks, cities can transform the way materials are used, managed, and circulated within the urban environment. At the same time, key urban goals such as improving access to housing, enhancing mobility, and fostering economic growth can be achieved in ways that promote prosperity, employment, public health, and community well-being. Moreover, rethinking material selection, utilization, and management can stimulate new opportunities for local manufacturing and production (Ellen MacArthur, 2019).

In response to the growing needs emerging at the regional level, the EU has recognized the importance of supporting necessary investments in circular economy. According to the EU Circular Economy Action Plan (European Commission, 2020), the objective is to leverage EU financial instruments so as to make circularity

practically applicable for citizens, regions, and cities alike. The overarching goal is to ensure that everyone benefits from this transition, leaving no one behind. The allocated funds are intended to enhance awareness, cooperation, and capacity building, while supporting regions in implementing circular economy strategies and strengthening their industrial fabric and value chains. In the context of promoting circular economy, the development of tailored solutions for outermost regions and islands, given their high dependence on imported resources, the increased waste generation attributed to tourism, and the challenges associated with waste exports, is of particular interest.

4. The Transition Towards Circular Cities in Greece

The Greek national strategy for circular economy (Ministry of Environment and Energy, 2018) recognizes its importance for the whole country, as the basic mean which could support a qualitative leap forward in the economy and pave the way for further development. At the same time, however, it is stated that circular economy constitutes a major and urgent need due to the great delay of Greece, the limited available resources and the particular geographical characteristics, of the country (i.e. insularity, remote mountainous areas).

The dominance of the centralized organizational model of the Greek state (Chlepas, 2021; Tsekos, 2022) significantly constrains the capacity of Local Government Organizations to develop innovative initiatives and policies—without this being the only systemic problem of the Greek local government system. The administrative reforms of the last two decades, namely the 'Kallikratis' (Law 3852/2010) and 'Kleisthenes I' (Law 4555/2018) programs, have established a more favorable framework regarding its role and competencies at the regulatory, organizational, and

operational levels (Hellenic Agency for Local Development and Local Government, 2020).

Particular mention should also be made of the broader challenges regarding the implementation of sustainable policies in Greece. As evidenced by the SDG Index for Europe, the country ranks 28th among 34 nations, indicating significant difficulties in aligning with sustainability targets (UN, 2025 c). Looking for example into recycling, which is a basic pillar of municipal circular policy, based on the assessments on the reports of the European Environment Agency (2025), Greece is considered to be at risk of missing its European waste management targets. Specifically, the attainment of the 2025 goals for preparing municipal waste for reuse and recycling, as well as the recycling target for total packaging waste, are considered precarious. Furthermore, the country is assessed as being at risk of deviating from the 2035 landfill target for municipal waste.

It is also noted that no progress has been recorded in improving the municipal waste recycling rate since 2019. Concurrently, the landfilling rate has remained stagnant at high levels, approximately 80%. Indicative of the existing deviations, the recycling rate in 2022 amounted to only 17%, a figure which is significantly below the estimated EU-27 average for the corresponding period, which reached 49%.

Leveraging the flexibility mechanisms inherent in European legislative frameworks, Greece has formally requested a five-year extension for its 2025 recycling mandates. This postponement encompasses municipal waste as well as plastic and glass packaging streams. The strategic implementation plan accompanying this request remains under review, pending final approval from EU regulatory bodies (European Environment Agency, 2025)

Greece is regarded as one of the countries in Europe that lags behind in terms of both the awareness of circularity and the adoption of circular economy business models across industries, cities, and regions. Greek municipalities, despite their diversity and distinct characteristics, can generally be viewed as being in a transitional phase with respect to the development and implementation of circular policies and models, which remain at an early stage of maturity. Nevertheless, discussions among municipal stakeholders, as well as the initiatives currently being undertaken, indicate that circular policy-making is becoming an increasingly prominent component of their strategic agendas. Furthermore, there is a growing recognition among local authorities in Greece of the significance of circular practices. Despite this emerging momentum, the challenges and barriers that municipalities must confront continue to be considerable (Alexopoulos et al, 2025).

5. The case of Greek Island Municipalities

5.1 Overview

This section focuses on Greek Island municipalities and examines certain circular economy issues such as awareness of and familiarity with the concept of circular economy, the current level of implementation of circular policies, the main barriers faced, the actions needed to overcome them and further promote circular practices and finally, the perceived benefits arising from the adoption of circular policies.

5.2 Research Methodology

The study is based on a primary quantitative research, conducted via a structured questionnaire which was distributed through Google Forms and sent via email to all, 74 island municipalities in Greece. Completed questionnaires were received by the 16 municipalities (i.e. 21,6 % of the population) listed below (Table 1).

Table 1: Island Municipalities Participating in the Research

	Name of Municipality	Population	Island	Region
1.	Agathonisi	202	Agathonisi	South Aegean
2.	Anafi	293	Anafi	South Aegean
3.	Argostoli	23.574	Kefalonia	Ionian Islands
4.	Viannos	4.436	Crete	Crete
5.	Gavdos	142	Gavdos	Crete
6.	West Lesvos	24.721	Lesvos	North Aegean
7.	Thira	15.480	Thira	South Aegean
8.	Kalymnos	17.752	Kalymnos	South Aegean
9.	Malevizi	25.734	Crete	Crete
10.	Mytilene	59.034	Lesvos	North Aegean
11.	Oinousses	911	Oinousses	North Aegean
12.	Sitia	20.438	Crete	Crete
13.	Symi	2.603	Symi	South Aegean
14.	Syros	21.124	Syros	South Aegean
15.	Faistos	23.921	Crete	Crete
16.	Chios	50.361	Chios	North Aegean

These island municipalities, characterized by distinct features regarding their size, degree of isolation and other geographic specificities, were classified into three main clusters:

- Small and very small island municipalities: The first group includes the municipalities of Agathonisi, Anafi, Gavdos, Symi, and Oinousses, each constituting a single municipal unit.
- Medium and large island municipalities: The second group comprises of Thira (Santorini), Kalymnos, Argostoli, West Lesvos, Mytilene (both in the island of Lesvos), Chios, and Syros.
- Municipalities of Crete: Finally, the third group includes four municipalities located in Crete, Greece's largest island, specifically Viannos, Malevizi, Sitia, and Faistos.

In most cases, the questionnaire was directed to the municipalities' central email address, with a formal request to be forwarded to staff members and officials possessing expertise or experience in the field of circular economy. Hence, the total

number of 21 complete questionnaires exceeds that of the participating municipalities (16) as, in some instances, more than one individual from the same municipal unit, with relevant professional knowledge, provided responses. The respondents included Mayors, Directors, Heads of Departments and members of the administrative staff. The respondents, apart from providing their demographic data and affiliation with the municipal unit were also asked to answer the following core research questions (RQs):

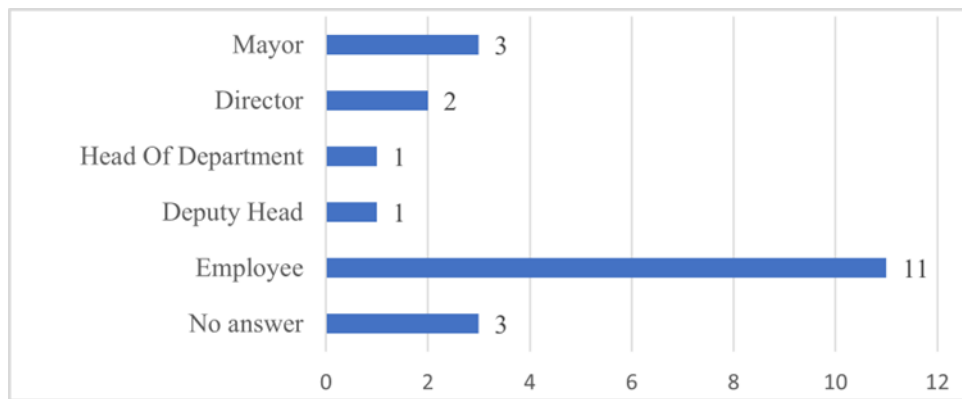
- RQ1: To what extent are the local authorities familiar with the concept of the circular economy?
- RQ2: What is the current level of implementation of circular models and in which specific sectors are they applied?
- RQ3: Which are the primary barriers and challenges encountered during the transition?
- RQ4: Which are the strategies that may function as catalysts for further promotion of the circular economy?
- RQ5: Which are the perceived benefits and future prospects arising from the adoption of circular practices?

5.3 Data Analysis

The data collected has been processed using descriptive statistics techniques and the results are summarized below.

Figure 1 displays the organizational positions of the respondents.

Figure 1: Organizational Position

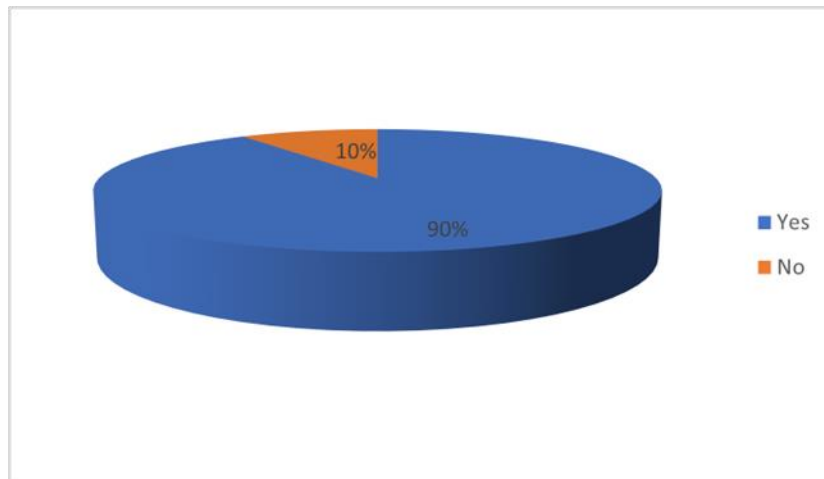


As we can see, the majority of the respondents (11 individuals, representing 52% of the sample) were members of the municipalities' administrative staff, 4 held various positions of responsibility (2 Directors, 1 Department Head, and 1 Deputy Department Head), 3 were Mayors and finally 3 did not provide their affiliation with the municipality.

The following two figures (Figure 2 and Figure 3) refer to the second research question (RQ2) and illustrate respectively the extent to which the representatives of the local authorities were aware of and familiar with the concept of the circular economy. Regarding their awareness, the respondents were asked to answer a yes/no question while in the case of familiarity they had to select one from a set of five predefined levels. All the respondents answered this question.

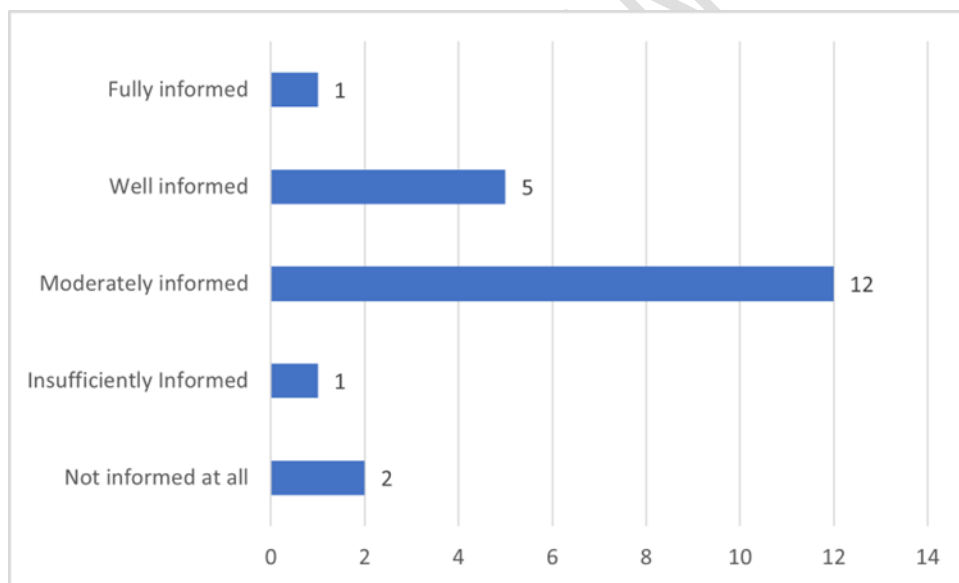
According to Figure 2, the overwhelming majority of the respondents (90%) declared aware of the concept of circular economy.

Figure 2: Awareness of the concept of Circular Economy



However, when it came to familiarity, which implies a deeper understanding of the subject, the picture changed.

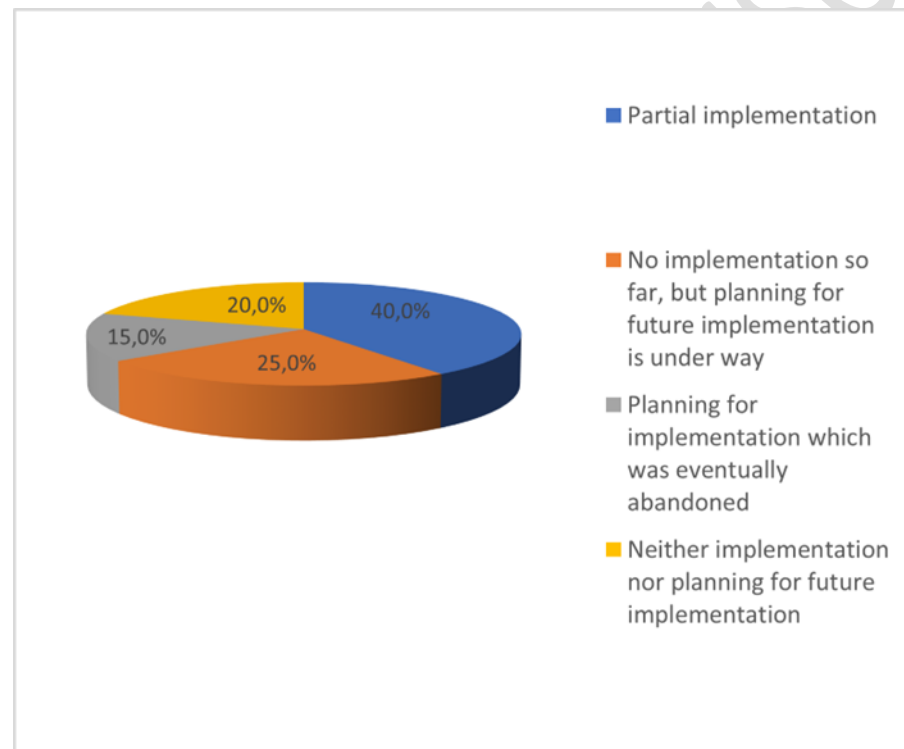
Figure 3: Familiarity with the concept of Circular Economy



As we can see from Figure 3, only 5 % of the participants (1 respondent) stated fully familiar with the concept of circular economy, 24% (5 persons) well-informed, while 57% (12 individuals) moderately informed. Finally, 5% (1 respondent) considered themselves insufficiently informed, while 10% (2 respondents) indicated that they had no information at all.

The following two figures (Figure 4 and Figure 5) refer to the second research question (RQ2) and illustrate respectively the current level of circular models' implementation as well as the specific sectors where these models are applied (Figure 5). Regarding the level of circular models' implementation, the respondents had to select one from a set of four predefined levels, while in the case of field of application they had to select as many fields as they wanted from a set of ten predefined sectors. Please note that all the respondents answered the first part of the research question while only seven of them (33%) responded to the second part by selecting at least one field.

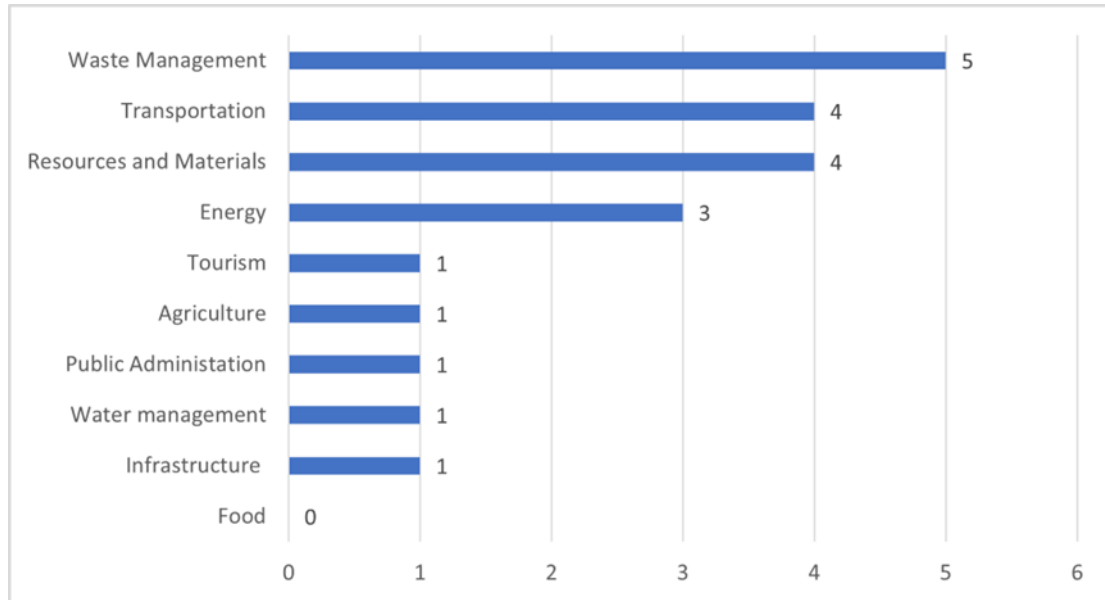
Figure 4: Level of implementation of Circular Models



According to Figure 4, 40% of the respondents indicated partial implementation of circular economy models noting, however, that none of them had been fully developed yet, while 25% stated that, although no circular models had been implemented so far, there were plans for their adoption in the future. Moreover, 15% of the participants noted that although there were plans for implementing circular

practices, they were eventually abandoned. Finally, the remaining 20% stated that there has been neither implementation nor planning for future application.

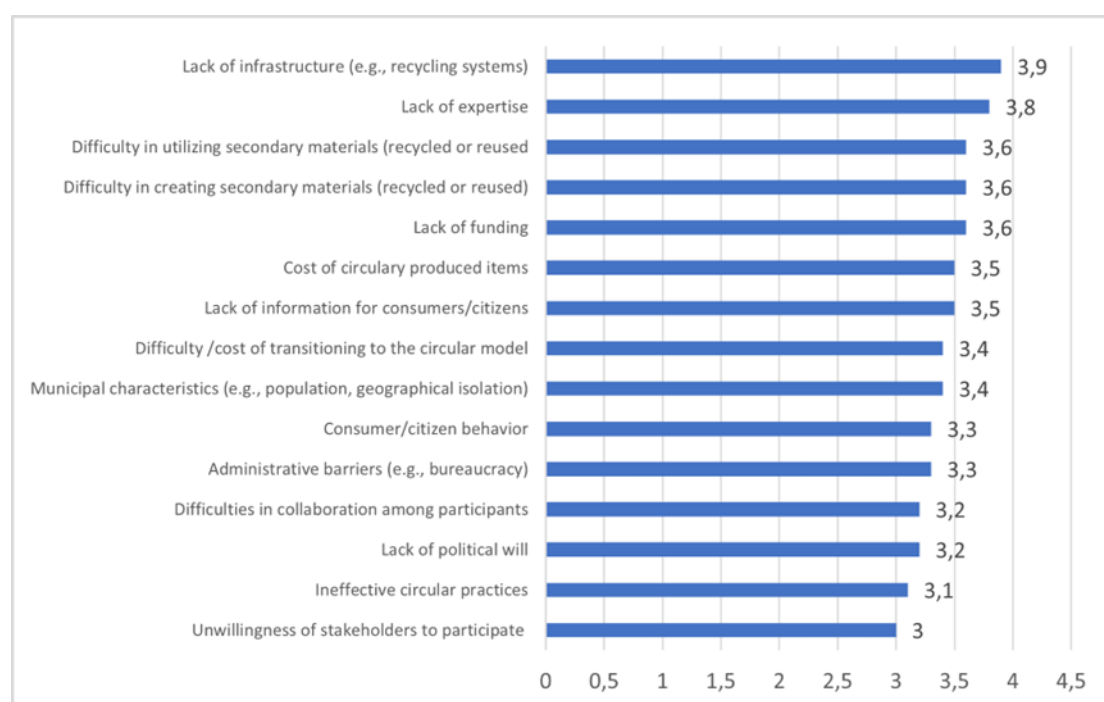
Figure 5: Fields of Circular Models implementation



Regarding the fields of circular models' application (Figure 5), waste management emerged as the dominant field (5 selections), followed by transportation as well as resources and raw materials (4 selections each) and energy (3 selections). From the remaining fields tourism, agriculture, public administration, water management and infrastructure, had one selection each, while food had no selection.

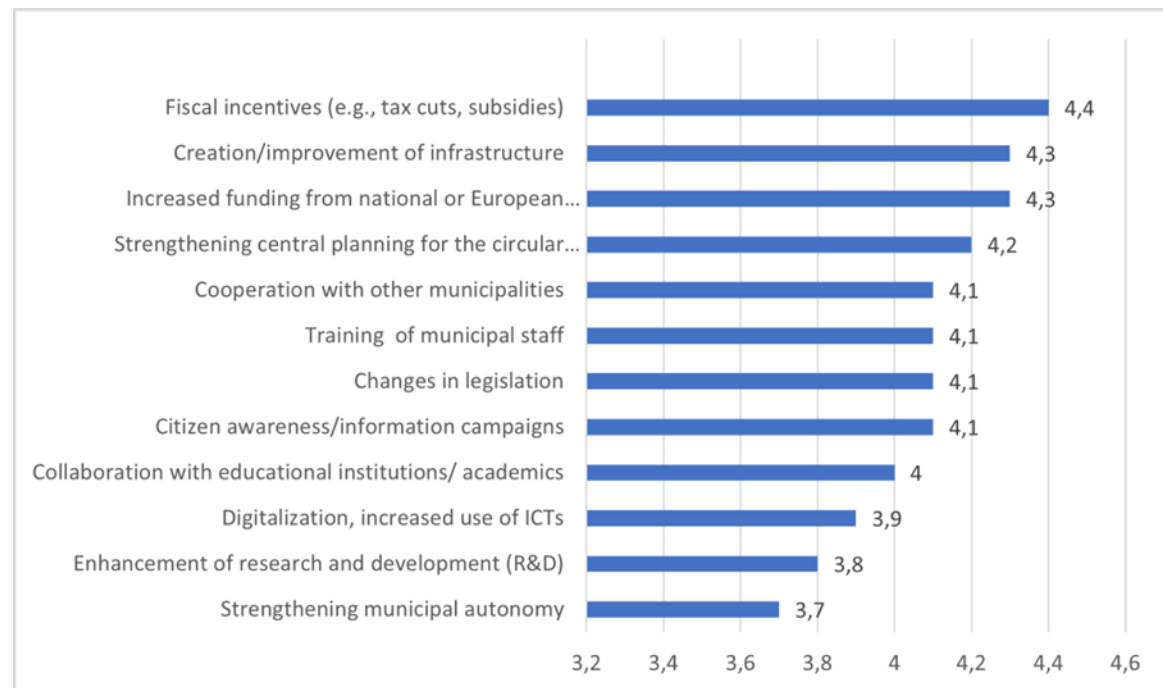
The following two figures (Figure 6 and Figure 7) refer to the third and fourth research questions (RQ3 and RQ4) and display respectively the respondents' assessment of both the main barriers to the implementation of circular models (RQ3) and the required strategies to overcome them and promote circular practices (RQ4). The respondents had to evaluate all the entries of two predefined sets of barriers and promotion strategies respectively, using a five-point Likert scale (1: lowest score, 5: highest score). All the respondents answered these questions.

Figure 6: Barriers to Circular Models Implementation



As we can see from Figure 6, the lack of infrastructure was identified as the primary obstacle, with a mean score of 3.9, indicating high significance, followed by the lack of expertise ($M=3.8$) and the difficulty in utilizing and producing secondary raw materials, as well as the lack of funding ($M=3.6$). Moreover, factors like cost of raw materials, lack of consumer/citizen information, transition costs, specific local characteristics of each municipality, consumer behavior and administrative barriers, such as bureaucracy, scored between 3.3 and 3.5, indicating moderate significance. Finally, factors like lack of political will, difficulties in stakeholder cooperation, ineffective circular practices and lack of stakeholder participation, scored between 3 and 3.2, indicating low significance.

Figure 7: Circular Economy Promotion Strategies

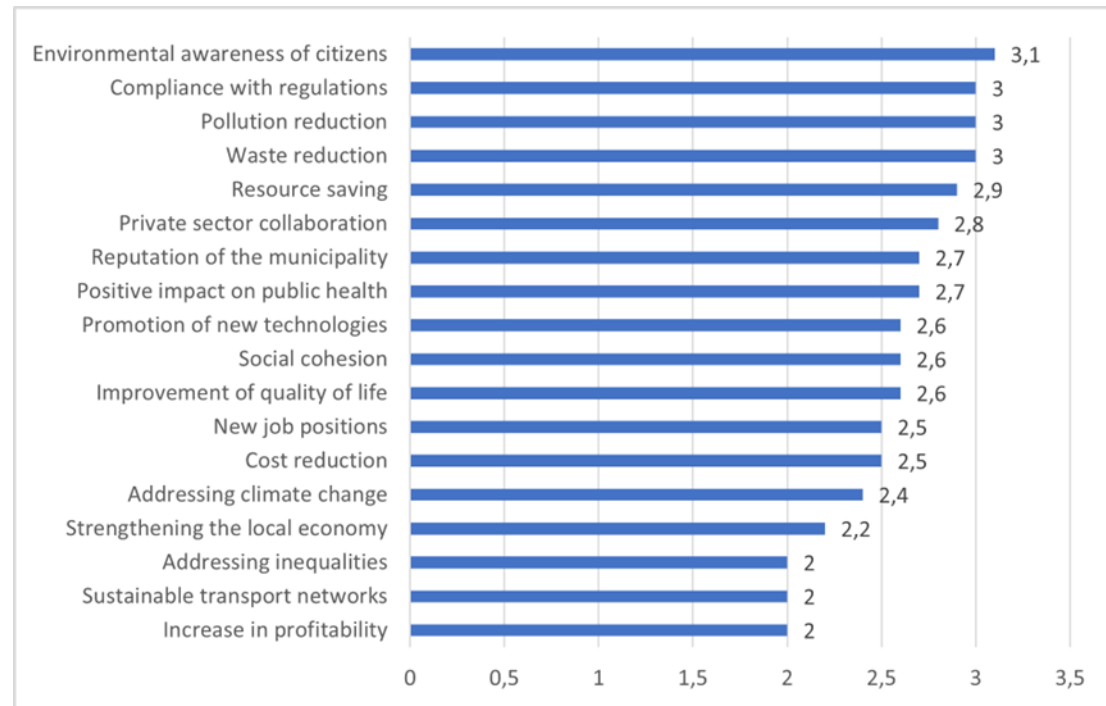


As we can see from Figure 7, fiscal incentives proved the most critical factor, with a mean score of 4.4, indicating high significance, followed by improvement of infrastructure and increased funding from national and European resources (M=4.3) as well as strengthening central strategic planning for circular economy (M= 4.2). Factors like inter-municipal cooperation, personnel training, legislative reforms, public awareness campaigns and collaboration with educational institutions/ academics, scored between 4 and 4.1, indicating moderate significance. Finally, factors like digitalization and ICT integration, enhancement of research and development (R&D) and reinforcement of local autonomy, scored between 3.7 and 3.9 indicating low significance

The final figure (Figure 8) refers to the fifth research question (RQ 5) and illustrates the respondents' perceptions regarding the benefits derived from the implementation of circular practices. In this case too the respondents had to assess all the entries of a

predefined set of potential benefits using a five-point Likert scale (1: lowest score, 5: highest score). All the respondents answered this question.

Figure 8: Benefits of Circular Practices



As we can see from Figure 8, the scores of all potential benefits are relatively low indicating the low expectations of the respondents. The improvement of citizens' environmental awareness was the highest-ranked benefit, with a mean score of 3.1, followed by compliance with the institutional framework, pollution reduction, and waste reduction, (M=3.0) and resource saving (M=2.9). Factors like promotion of new technologies, improvement of quality of life, social cohesion, job creation and cost reduction, scored between 2.5 and 2.9. Finally factors like, addressing climate change, strengthening the local economy, addressing inequalities, sustainable transport networks, and increased profitability, scored between 2.0 and 2.4.

6. Discussion of the main findings

The main data analysis findings are summarized and discussed below:

Regarding awareness of and familiarity with the concept of Circular economy (RQ1) although 90% of the respondents claimed to be aware of it, when it came to familiarity only 5% of them declared fully familiar, 24% well-informed 57%, moderately informed, while approximately 10% stated that they have no relevant information. Although this finding appears less than encouraging, it must be interpreted within the specific context of island municipalities, most of which are medium and small. Hence, the staff of their municipal units is limited, mainly preoccupied with day-to-day activities and practically unable to engage in innovative practices, such as the implementation of circular models. The fact that three of the questionnaires were completed by the mayors themselves is indicative and highlights the lack of specialized administrative staff.

Regarding the level of circular models' implementation (RQ2- part 1) the findings suggest that circular activity is gradually gaining ground as 80% of the participants had experienced, to various degrees, either planning or partial application of circular economy models, while the remaining 20%, declared unaware of either plans or implantation of circular practices. This finding can be interpreted as a positive initial step, primarily reflecting a growing familiarity with circular economy principles and their gradual integration into municipal policy agendas, thereby shaping a potential framework for future development.

Concerning the sectoral application of circular models (RQ2- part 2), waste management emerged as the dominant field followed by transportation, natural resources and raw materials, as well as energy. Other sectors, such as water, agriculture, public administration, and construction/infrastructure, had much lower

scores indicating minimal activity in these areas. It is worth noting that only 33% of the respondents have answered this specific question and this may be attributed to lack of either specialized knowledge or practical experience, regarding the technical implementation of circular practices across diverse operational fields.

Regarding the main barriers to a wider circular models' implementation (RQ3), the lack of infrastructure emerged as the most critical barrier, with a mean score of 3.9 indicating high significance, followed by the lack of human resource expertise (M=3.8), the challenges of utilizing and producing secondary raw materials and the lack of funding (M= 3.6). Relatively lower significance was attributed to the difficulties concerning transition costs and the specific local characteristics of each municipality (M=3.4) as well as to consumer behavior and administrative barriers, such as bureaucracy (M=3.3). The aforementioned difficulties, perceived by the respondents with varying intensity, depending on the unique traits and needs of each municipality, constitute a multifactorial framework which significantly influences and explains their observed low expectations regarding the successful implementation and outcomes of circular models.

Regarding the actions and strategies required to overcome the barriers and promote circular economy (RQ4), those linked the financial support of the municipalities seem to be the dominant ones. More specifically, fiscal incentives were ranked first, with a mean score of 4.4 indicating high significance, followed by the development or improvement of infrastructure and the increased funding from national and European resources (M=4.3) as well as the reinforcement of central strategic planning for circular economy promotion (M= 4.2). Conversely, actions such as enhancing Research and Development (R&D) (M=3.8) and strengthening local autonomy (M=3.7) were perceived as relatively less effective. These responses reflect, to a

certain extent, a long-standing dependency of the municipalities on the central government. They further highlight that the centralized model of Greek public administration, which is deeply rooted in the historical processes that shaped its evolution and has fostered a paternalistic approach, within which local government authorities encounter significant difficulties in taking initiatives, particularly when those initiatives involve innovative practices such as circular economy models.

Finally, regarding the potential benefits stemming from the application of circular economy models (RQ5), all of them yielded surprisingly low scores, indicating moderate to low importance. The improvement of citizens' environmental awareness was identified as the most significant benefit with a mean score of 3.1, followed by the compliance with the institutional framework, pollution reduction, and waste reduction, (M=3.0). Conversely, addressing inequalities, developing sustainable transport networks, and increasing profitability were ranked lowest, with a mean score of 2.0. These findings are particularly significant as they highlight the low expectations of the respondents regarding the impact of circular practices on island municipalities. Such modest expectations may stem from a lack of in-depth understanding of the potential outcomes of circular models. More likely, however, they are the result of a complex, multi-factorial framework of barriers that must be addressed to render the implementation of these models feasible.

7. Conclusions

On a global scale, the circular economy model has emerged as perhaps the most critical pathway toward a sustainable reorganization and operation of the economic system. At the same time, it carries profound social and environmental implications,

serving essentially as the framework that integrates the core principles of sustainable development.

The discouraging findings regarding the achievement of sustainability goals, both globally (UN, 2025b) and in Greece (UN, 2025c; EEA, 2024), provide compelling arguments for further strengthening and accelerating the transition from the linear to the circular model.

While a shift towards circular awareness is gaining traction among Greek local authorities, the actual integration of circular models remains at an early, transitional stage. Significant barriers continue to impede progress, offsetting the developing momentum across the country's diverse municipalities (Alexopoulos et al, 2025; Angelis et al 2023). Conversely, the prioritization of the circular economy is surely reflected on the ongoing dialogue and the operational measures adopted by the Central Union of Municipalities of Greece, making clear that circular policies have secured a prominent position on their strategic agenda (KEDE, 2025).

This research contributes to the existing literature by providing a targeted empirical analysis of circular economy integration within the unique context of Greek island municipalities. Unlike broader regional studies, this paper treats islands as closed systems with finite resources and distinct geographical constraints. For them, the linear economic model appears to be excessively costly and environmentally unsustainable. Transitioning to a circular model could transform the inherent disadvantages of insularity into opportunities for sustainable development.

Furthermore, a key novelty of the study is the identification of a significant awareness-familiarity gap among local authorities' representatives. More specifically, while general awareness of circularity is high, technical familiarity and

implementation maturity remain at an early, transitional stage. The transition is significantly impeded by a lack of infrastructure, limited technical expertise, and a centralized and paternalistic administrative structure that fosters municipal dependency on the central state. Finally, the research reveals a surprising trend of low expectations from the respondents, regarding the benefits and social impact of circular models in insular environments.

As evidenced by the research conducted in the Greek islands, despite significant implementation challenges and skepticism regarding potential benefits, there is a discernible trend toward the gradual strengthening and integration, to varying degrees, of circular practices into municipal policies. Furthermore, successful paradigms within the Greek territory, such as the cases of the islands of Tilos, Astypalaia, and Agios Efstratios, have already demonstrated significant results. This, undoubtedly, represents a pivotal shift that transcends technical expertise, political will, and resource availability. It is deeply rooted in the social culture and the unique characteristics of each community, a point further emphasized by the case study of Tilos (Alexopoulos et al., 2025). Particular emphasis must be placed on this dimension through targeted actions to ensure the successful management of this transition.

Based on the research findings and the specific barriers identified in the Greek island municipalities, the following proposals and policy recommendations would be beneficial.

To effectively promote the circular economy in island municipalities, the study proposes enhancing fiscal incentives and increasing funding from national and European resources. It is also essential to strengthen central and local strategic planning alongside the development of infrastructure and the provision of specialized

technical training for municipal staff. Raising awareness among the local community and stakeholders is particularly critical, through the implementation of information campaigns as well as the strengthening of participatory and consultation initiatives. Furthermore, legislative reforms are required to enhance local autonomy and reduce administrative dependency on the central state, while enhancing cooperation between municipalities, the private sector, the academic community and civil society to develop innovative solutions.

The success of the transition to a circular economy model in insular areas depends on overcoming structural barriers, while simultaneously leveraging the opportunities created by the unique characteristics of these regions. Transforming geographical disadvantages into sustainable development prospects requires profound social change, supported by successful local paradigms that highlight the importance of cooperation among all stakeholders.

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References

Alexopoulos A., Gourgoura E., Angelis V., (2025), Circular Business Models at Local Level: The case of the small island of Tilos, Greece: in Hyz A. and Kaldis P. (eds), Economic Integration: Strategies, Challenges, and Global Implications, Nova Science Publishers, inc. <https://doi.org/10.52305/SPJV6005>

Angelis-Dimakis, A., Arampatzis, G., Alexopoulos, A., Vyrkou, A., Pantazopoulos, A., Angelis, V., (2023) Industrial Symbiosis in the Balkan-Mediterranean Region: The Case of Solid Waste. *Environments* 2023, 10, <https://doi.org/10.3390/environments10010001>

Boulding, K. (1966), The Economics of the Coming Spaceship Earth. Διαθέσιμο σε: <http://www.ub.edu/prometheus21/articulos/obsprometheus/BOULDING.pdf>

Cervantes Puma, G. C., Salles, A., & Bragança, L. (2024). Nexus between Urban Circular Economies and Sustainable Development Goals: A Systematic Literature Review. *Sustainability*, 16(6), 2500. <https://doi.org/10.3390/su16062500>

Chlepas, N. (2021). Τοπική Αυτοδιοίκηση στη μετά Κορονοϊό Εποχή [Local Government in the Post-Coronavirus Era]. *DiaNEOsis*, https://www.dianeosis.org/wp-content/uploads/2021/01/Chlepas_January.pdf Accessed 03 September 2025.

Ellen MacArthur Foundation, (2012), Towards the circular economy vol. 1: An economic and business rationale for an accelerated transition. Cowes, UK: Ellen MacArthur Foundation,
<https://content.ellenmacarthurfoundation.org/m/4384c08da576329c/original/Towards-a-circular-economy-Business-rationale-for-an-accelerated-transition.pdf> Accessed 2 November 2025.

Ellen MacArthur Foundation, (2025)
<https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview#:~:text=It%20is%20based%20on%20three,%2C%20people%2C%20and%20the%20environment.> Accessed 17 October 2025.

Ellen MacArthur Foundation, SUN, McKinsey Center for Business and Environment (2015), Growth within: A Circular Economy Vision for a Competitive Europe
<https://content.ellenmacarthurfoundation.org/m/3d4eba36b0311c08/original/Growth-within-A-circular-economy-vision-for-a-competitive-europe.pdf> Accessed 5 October 2025.

Ellen MacArthur Foundation (2017), Cities in the Circular Economy an Initial Exploration, Published by the Ellen MacArthur Foundation,
<https://content.ellenmacarthurfoundation.org/> Accessed 10 October 2025.
Ellen MacArthur Foundation 2019, Circular Economy in Cities: Project Guide,
<https://content.ellenmacarthurfoundation.org/m/4352e3481ee127c3/original/Circular-economy-in-Cities-Project-guide.pdf> Accessed 23 October 2025.

European Commission (2016). Circular Economy: New Regulation to boost the use of organic and waste-based fertilisers. Fact Sheet/Press Release, Brussels,
https://ec.europa.eu/commission/presscorner/api/files/document/print/de/memo_16_826/MEMO_16_826_EN.pdf Accessed 1 October 2025.

European Commission.(2020)., A new Circular Economy Action Plan For a cleaner and more competitive Europe, https://eur-lex.europa.eu/resource.html?uri=cellar:9903b325-6388-11ea-b735-01aa75ed71a1.0017.02/DOC_1&format=PDF Accessed 10 October 2025.

European Environment Agency (2016), EEA Report No 2/2016, Circular economy in Europe Developing the knowledge base.
https://www.eea.europa.eu/publications/circular-economy-in-europe/at_download/file Accessed 6 October 2025.

European Environment Agency (2024), Accelerating the circular economy in Europe, State and outlook 2024, [file:///C:/Users/user/Downloads/TH-AL-24-002-EN-N%20Accelerating%20the%20circular%20economy%20in%20Europe%20\(2\).pdf](file:///C:/Users/user/Downloads/TH-AL-24-002-EN-N%20Accelerating%20the%20circular%20economy%20in%20Europe%20(2).pdf) Accessed 6 October 2025.

European Environment Agency, (2025) Waste management country profile with a focus on municipal and packaging waste Greece
<https://www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025> Accessed 8 October 2025.

Geissdoerfer M., Savaget P., Bocken N.M.P., Hultink E., (2017), The Circular Economy – A new sustainability paradigm?, Journal of Cleaner Production, Volume 143, Pages 757-768, ISSN 0959-6526, <https://doi.org/10.1016/j.jclepro.2016.12.048>
Geissdoerfer M., Vladimirova D., Evans S. (2018), Sustainable business model innovation: A review, Journal of Cleaner Production 198 (2018) 401-416, <https://doi.org/10.1016/j.jclepro.2018.06.240>

Hellenic Agency for Local Development and Local Government, (2020), Circular Economy and Local Government, https://www.eetaa.gr/eetaa/odhgoi/13102020_odhgos_kyklikhs_oikonomias.pdf. Accessed 05 September 2025.

KEDE (Central Union of Greek Municipalities) <https://kede.gr/tag/kykliki-oikonomia/>, Accessed 12 November 2025.

Kirchherr J., Reike D., Hekkert M., (2017), Conceptualizing the circular economy: An analysis of 114 definitions, Resources, Conservation and Recycling, Volume 127, Pages 221-232, ISSN 0921-3449, <https://doi.org/10.1016/j.resconrec.2017.09.005>.

OECD, (2020), The Circular Economy in Cities and Regions, OECD Centre for Entrepreneurship, SMEs, Regions and Cities, https://www.oecd.org/content/dam/oecd/en/publications/reports/2020/10/the-circular-economy-in-cities-and-regions_dd1348ed/10ac6ae4-en.pdf Accessed 9 October 2025.

OECD, (2025), The Circular Economy in Cities and Regions of the European Union, https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/04/the-circular-economy-in-cities-and-regions-of-the-european-union_d8d687d2/e09c21e2-en.pdf Accessed 10 October 2025.

OECD (2019), Business Models for the Circular Economy: Opportunities and Challenges for Policy, OECD Publishing, Paris. <https://doi.org/10.1787/g2g9dd62-en>
PACE, (2019), Circularity Gap Report, <https://shiftingparadigms.nl/wp-content/uploads/2019/01/CGR-2.0-report-final-reprint-web-20190326.pdf> Accessed 6 October 2025.

Oghazi P. and Mostaghel R., (2018) Circular Business Model Challenges and Lessons Learned—An Industrial Perspective, Sustainability 2018, 10, 739, doi:[10.3390/su10030739](https://doi.org/10.3390/su10030739)

Pearce, D., & Turner, R. K. (1990). Economics of natural resources and the environment. Baltimore: Johns Hopkins University Press
UN 2025, <https://sdgs.un.org/goals>

Tsekos T., (2022), Η ιστορική εξέλιξη και τα δομολειτουργικά χαρακτηριστικά της δημόσιας διοίκησης [The historical evolution and structural-functional characteristics of public administration]. In D. A. Sotiropoulos & V. Dalakou (Eds.), Το Σύγχρονο Διοικητικό Σύστημα στην Ελλάδα [The Modern Administrative System in Greece]. HOU (Hellenic Open University) Publications

United Nations, (2025A), <https://sdgs.un.org/goals> Accessed 20 October 2025.

United Nations (2025B) , UN report 2025 Progress towards the Sustainable Development Goals Report of the Secretary-General,
<https://unstats.un.org/sdgs/files/report/2025/secretary-general-sdg-report-2025--EN.pdf> Accessed 18 October 2025.

United Nations (2025C) Sustainable Development Solutions Network, Sustainable Development Report 2025, https://files.unsdsn.org/20250121-EU-SDR-2025_WEB.pdf , Accessed 15 November 2025.

US Department of Energy (2024) Circularity for Secure and Sustainable Products and Materials: A Draft Strategic Framework
<https://www.energy.gov/sites/default/files/2024-10/circularity-for-secure-sustainable-products-materials-report.pdf> Accessed 20 October.

Wells, P. and Seitz, M. (2005), "Business models and closed-loop supply chains: a typology", Supply Chain Management, Vol. 10 No. 4, pp. 249-251. doi:
[10.1108/13598540510612712](https://doi.org/10.1108/13598540510612712)