Circular Economy and Sustainability
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ORIGINAL PAPER

Circular Economy Behavior and Sustainable Healthcare

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Abstract
The healthcare sector faces significant challenges related to resource constraints, environmental impacts and increasing demand for services. This study examines how the integration of circular economy principles and organizational behavior can enhance the sustainability of healthcare systems. By implementing circular economy practices - such as waste reduction, material reuse and recycling - healthcare organizations can optimize resource use and minimize their ecological footprint. In addition, the role of organizational behavior is critical, as effective leadership, employee engagement and a supportive culture can lead to the adoption of sustainable practices that align with the organization's mission. An integrated approach that combines circular economy strategies with supportive organizational practices enhances system resilience, reduces dependence on finite resources and promotes broader environmental and social sustainability goals. This study scrutinizes the critical role of organizational behavior in terms of management's perception of climate change, the way a health organization operates in relation to staff mobilization and the views of its own staff always with climate change in mind and its effects. An analysis of a sample of 379 health professionals through a relevant questionnaire from the public and private sectors of the healthcare industry in Greece revealed a significant degree of detachment of the administrations from environmental concerns, with the simultaneous absence of motivation of the staff on corresponding issues, while negative was the health workers' overall perception of climate, showing significant challenges in communication in addition to education and awareness within the organization. Overall, this research provides a window into the adoption of Organizational Behavior and Circular Economy principles by healthcare organizations in order to ensure their sustainability.

Keywords Environmental Health · Sustainable Healthcare · Green Hospital · Organizational Behavior · Circular Economy

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Introduction

The modern world faces numerous environmental and social challenges, with global warming emerging as one of the most pressing threats due to its impact on essential human needs such as clean air, safe drinking water, food security, and adequate shelter [1, 2]. While the healthcare sector plays a vital role in safeguarding public health, it also significantly contributes to environmental degradation. According to the 2022 Healthcare Without Harm (HCWH) annual report, healthcare systems worldwide account for more than 4% of total greenhouse gas (GHG) emissions, highlighting an urgent need for sustainable reforms within the industry [3, 4].

The COVID-19 pandemic has further emphasized the critical relationship between environmental sustainability and public health, reinforcing the necessity for resilient and eco-conscious healthcare systems [5]. In response to these challenges, reducing the environmental footprint of healthcare has become a core objective within the United Nations' 2030 Agenda for Sustainable Development, ensuring long-term sustainability and an improved quality of life for current and future generations [1]. The European Union (EU) Green Deal has also set ambitious targets, aiming for a climate-neutral and emission-free future by 2050, with a strong emphasis on protecting human health through sustainability initiatives [6, 7].

A promising approach to achieving these goals is the Circular Economy (CE), a transformative economic model that seeks to minimize resource consumption, reduce waste, and optimize sustainability across various industries, including healthcare [8, 9]. CE represents a shift away from the traditional Linear Economy (LE), which follows a "take-make-dispose" pattern, toward a more regenerative system that extends product lifecycles, enhances resource efficiency, and promotes environmentally responsible business models [9].

As highlighted in [10], the shift towards a CE is considered a prerequisite for achieving long-term sustainability. The concept of CE is inherently interdisciplinary, integrating knowledge from various fields to combine ecological protection with economic growth, fostering sustainable development [11]. Rather than representing a single concept, CE serves as an umbrella framework that incorporates diverse principles and methodologies, including Cradle to Cradle, Industrial Ecology, Biomimicry, Performance Economy, Blue Economy, Natural Capitalism, and Industrial Capitalism [12]. Applying CE strategies in the healthcare sector could thus be an effective response to growing environmental pressures. Specifically, CE aims to reduce pollution and waste generation while simultaneously creating economic value [13], relying on the responsible and efficient use of natural resources [14].

Furthermore, CE plays a central role in steering economic growth toward sustainability by decoupling development from resource consumption through reduction, reuse, and recycling [15]. In practice, the implementation of CE strategies involves reducing the environmental footprint of production, promoting reuse and recycling, and fostering behavioral changes in both consumers and organizations to align with circular principles [13]. Accordingly, healthcare institutions — like all other organizations — can significantly contribute to environmental sustainability through responsible practices [16].

Additionally, scholars argue that the transition toward circularity is closely linked with digital transformation [17]. Industry 5.0, which emphasizes the collaboration between human creativity and advanced technologies, has the potential to enhance patient care through personalized health monitoring and tailored medical solutions [18]. In parallel, green innova-

tion or eco-innovation supports environmental management by driving advancements in processes and technologies that reduce pollution and limit the depletion of natural resources [19]. This aligns with the "triple bottom line" approach, which balances social, environmental, and economic priorities [20].

Given the considerable environmental impact of the healthcare sector and the urgent need for sustainable development, this study aims to explore how the sector integrates circularity, highlighting the most representative CE practices currently implemented. Reference [21] points to numerous unexplored sustainability opportunities that remain insufficiently addressed in existing research. Therefore, adopting CE principles can serve as a strategic pathway toward achieving specific SDGs, such as fostering responsible consumption and production (Goal 12) [22].

Despite the growing interest in CE, its application within the healthcare sector remains limited. Existing research primarily focuses on Healthcare Waste Management (HWM), while broader circularity principles—such as sustainable procurement, eco-friendly infrastructure, and circular supply chains—are underexplored [1]. Given the complexity of the healthcare sector, integrating CE requires a multidisciplinary approach involving healthcare professionals, policymakers, and sustainability experts [8]. Moreover, the transition to CE is influenced by key behavioral and organizational factors, particularly Organizational Behavior (OB) and Environmental Education (EE), which play a crucial role in shaping sustainability practices within healthcare organizations [9].

To address this research gap, our study provides a comprehensive, state-of-the-art overview of CE applications in healthcare. Specifically, we investigate CE as a strategic tool for hospital management and examine the role of Organizational Behavior (OB) and Environmental Education (EE) in fostering sustainability-driven behaviors within healthcare institutions. The study aims to answer the following key research questions:

- How is CE applied to inform decision-making in hospital management?
- How do OB and EE contribute to the successful implementation of CE models in healthcare organizations?

To provide empirical insights, we conducted a large-scale study within the Greek healthcare sector, collecting data from the seven regional Health Districts and private clinics. A total of 379 Greek healthcare professionals participated in the research, including administrative, medical, nursing, and technical staff. This diverse sample allows us to capture a comprehensive perspective on the behavioral and organizational factors influencing CE adoption in healthcare.

By analyzing key organizational behavior elements related to environmental sustainability, this study seeks to identify enablers and barriers to CE implementation within healthcare institutions. Furthermore, we offer practical recommendations for healthcare managers and policymakers, aiming to bridge the gap between theoretical CE principles and real-world healthcare applications. Ultimately, this research contributes to the broader discourse on sustainable healthcare transformation, aligning with global efforts to mitigate climate change and enhance environmental responsibility within the sector.

Circular Economy and Health Care System

The healthcare industry takes a great toll on the environment and with the focus on the need to attain sustainable development, the circular economy concept is being embraced as manufacturers and consumers engage in recycling and reuse strategies to eliminate waste ending up in the world's dumpsites [11, 23, 24]. The realm of circular economy deals with optimal utilization and reuse of resources within the various stages of production chains, ranging from extraction of raw materials to consumption and disposal phases [25]. In making optimal use and reuse, the environmental, economic, and social costs and benefits are taken into account [26]. The circular economy is not just an end but also a means to resolve many underlying problems. It could diminish pressure on the environment as regards resource extraction, processing, usage, and disposal; reduce short-term and long-term supply risks; and foster economic growth [27]. Numerous strategies exist for minimizing consumption of resources and materials. With respect to environmental perspective, ranking resource usage strategies can be done. In general, order of preference is as follows: prevention, reuse, recycling [28]. This line of thinking is very much connected to various waste management hierarchies where the top priority is avoiding generation of waste after which recycling or recovery processes may be undertaken [28]. Over time adjustments have been made on this general ranking while within literature there are several "circularity ladders" having between three up to ten discrete circular utilization approaches [29]. Normally, those who employ circularity strategies of great import use lesser quantities of primary materials. Higher strategies for circularity also consume lesser levels of natural resources like land, water and ecosystem services. Additionally, it is assumed that there are lesser further adverse environmental impacts from the production of primary materials [29]. But still, one must be careful to consider that dematerialization will not always lead to constant decreases in environmental pressures [30]. A comprehensive environmental assessment with regards to the whole product life cycle, including positive and negative impacts must be conducted [30, 31]. It is, however, rather limited in providing current practical guidance. Applying this quite liberal and global definition of resource management to health care, the subject of circular medicine is to be discussed. This extension is especially pertinent because sustenance is not easily provided in hospitals as they generate large amounts of waste, and minimal is actually recycled or reclaimed in any environmentally friendly manner [32].

However, there are various unutilized sustainable opportunities waiting to be exploited in context with healthcare [33], CE might be able to bring forth both economic and environmental situations in the rising threats [34, 35]. A CE mainly concerns with pollution and wasterization to form more people-oriented used of resources, and it assumes one of the most important systematic functions in integrating the socio-economic development in to sustainability [21, 34] which is a profitable system consisting of the decoupling of improvements of economy and decrease and recycling of natural resources. In this regard, a CE could be viewed as a channel through which certain SDG can be realized through influencing the behavior of facilities and adopting sustainable options [9].

From 2016 to 2021, the bibliometric analysis of D'Alessandro and his partners showed that the application of the CE concept to the healthcare sector is a relatively recent development, while they are pointing out, that the increasing number of articles which published between 2021 and the present indicates the growing interest of researchers on this topic [1].

In healthcare, single-use plastics, medical devices, and the large volume of waste generated are some of the crucial problems that a CE model can solve [13].

Practices like mechanical recycling of clinical plastic waste, reusable medical equipment, and environmentally conscious product design could be a cohesive framework for reorganization at the system level, and by using innovation and creativity, they can pave the way to a constructive and regenerative economy [1, 36]. By addressing barriers associated with sustainability in the healthcare sector, CE practices, promoting sustainable resource management and elimination of waste and pollution, hold a crucial role in meeting the Sustainable Development Goals (SDGs) [37].

Although, reusing medical devices and reducing material and energy consumption are common practices aimed at enhancing sustainability in the healthcare sector, there are several barriers that limit the widespread adoption of circular design principles, such as safety concerns, difficulties in collecting and separating devices, regulatory constraints, financial constraints and lack of awareness [38]. To address these challenges and promote greater circularity in the health sector, opportunities exist through targeted policy interventions, technological innovations, economic incentives, improved collaboration between stakeholders and the application of systems thinking.

To recap, the application of circular economy strategies in the healthcare system holds a promising potential of lowering the environmental burdens, pursuing sustainability and revenues on the health area. In future, as the sector also transitions to observe relative sustainability, the sector can be aligned to other social objectives of supporting a healthier planet and human populace. To create a solid and renewed green culture in human based sector such as a healthcare industry, there is necessity for using transition techniques to a circular economy plan for attracting and engaging all employees of the organizations and management of the organizations; however, it should be recognized that more-than-legislative engagement is required in the creation of fulfilling green change [14, 39]. Although the environmental behavior of healthcare workers is an important strategy for implementing environmental management goals within the structure of healthcare [38], Organizational and behavioral change is also one of the pillars for its realization.

Organizational Behavior, Circular Economy as Pillars To Green Hospitals and Sustainable Healthcare Organizations

Implementing the principles of organizational behavior along with those of the circular economy is essential for the formation of effective and resilient healthcare systems because interaction between these concepts enhances resources, environmental management and stability [15]. This paper has underlined the concept of circular economy practices that provided adequate OB to lower the environmental impact of healthcare, such as waste minimization, resource conservation, and lower emission to turn the vision of a green hospital into reality. For instance, sterilizing instruments and general wastes recycling decreases raw material demand and till ‘waste’ respectively [16]. This case is cross-cuts in organizations’ sustainability where cost savings arise from measures implemented that decrease expenses in waste management, acquisition of new resources and energy [17]. Organizational behavior assists in the review and control of such savings via proper utilization of resources in an organization [17].

Moreover, organizational behavior addresses such issues as employees' engagement, as well as their ongoing training and education [40–42]. As the implementation of circular economy key is often accompanied by the changes of processes and perceptions within an organization, the knowledge derived from OB will allow the understanding of change, how people resist it and how it is possible to build a culture of change [17]. Proper management of change facilitates easier transition to better practices [43]. The implementation of principles of top organization behavior such as effective line of communication and collaborative work setting contribute to the process of implementing circular economy. Appropriate multi-stakeholder coordination also guarantees that sustainability happens in multiple sectors of the organization starting with the acquisition of raw materials and ending with proper disposal of waste [44]. This integration is done by the leaders within healthcare organizations since they are the ones who set goals and standards that are sustainable with an aim of encouraging circularity among their workers [45].

The principles of green hospitals developed by Howard and based on the definition of the US Office of the Federal Environmental Executive can be seen as an application of the system approach to improvement of resource saving and restriction of adverse effects on the environment in health care organizations [46]. It drives the efficient use of energy, water, and materials by enhancing the design, construction, and management of buildings and structures, thus lowering the environmental impact of the construction industry while safeguarding people's health [46]. Overall, Fadda's evaluation of the ten crucial components for developing green health systems is well aligned with Organizational Behavior and emphasizes several key fields for further enhancement where leadership by education and responsibility, alteration of toxic reagents, proper management of wastes, efficient energy-saving endeavors, and green purchasing policies constitute the key areas of advancement [47]. Each of them is supposed to contribute to the environmental protection alongside with the improvement of productivity and economies of scale in the spheres of activity of the healthcare organizations.

But still, despite these obvious advantages, there is a severe identification deficiency of sustainable development in the framework of the environmental influence of the healthcare segment and the necessity for its transformation. Leadership is identified as being essential at the organizational, manager, and employee levels for the purpose of facilitating change, pro-green policies, sustainability particularism [48]. This leadership role is not only limited to the operational practices of the health facility but also entails the patronage of environmentally responsible approaches among the health professionals and other stakeholders [49]. Fortunately, the experiences of other countries show that green leadership is possible, and healthcare systems can show the world how, through the use of innovative practices that would simultaneously work towards improving environmental stewardship and enhancing the clients' health [50–55].

Sustainable health care is even defined as the art of improving the overall health of patients and healthcare workers while preventing deterioration of health within healthcare structures through manners such as the minimization of waste and contamination [56].

To sum up, Organizational Behavior facilitates the development of organizational culture to ensure positive health climate, which increases patients' and staff's well-being. The enhancement of the sustainability strengthens the healthcare systems depending on its ability to provide for resources in the future. The significance of Organizational Behavior in promoting organizational change and developing appropriate solutions towards growth is

based on the principle of constant development and effective innovation in accordance with the environmental and economic opportunities. Sustainability initiatives point to a company's demonstrable care for the welfare of the community thus improving on the company's image in the market. Managing Organizational Behavior makes sure that all the interest groups, the community inclusive, embrace and support the concept of sustainability.

Therefore, it could be concluded that Organizational Behavior as well as the circular economy work in a cooperative manner to form a sustainable healthcare system. Organization behavior: For circular economy to be employed, leaders and the employees have the capacity to execute what has been proffered here. In aggregate, these strategies lead to minimization of the effects on the environment, operational cost saving, better health care, increase in the level of resiliency and community engagement hence and lead to a holistic and sustainable approach to healthcare.

The Role of Environmental Health Education to the Transition to a Sustainable Future for the Healthcare Organizations

Despite the recognition of the adverse effects of climate change on health as well as the principle of sustainable healthcare, most of the HCPs are deficient in the theoretical understanding and concrete abilities of the change towards environmentally sustainable practices [57]. In many cases existing literature reinforces that staff education and training of healthcare organizations as well as the enhancement of certain technical competencies is one to execute greenness in healthcare [48, 58–60]. Although it is widely recognized that education is crucial for transitioning into a more sustainable and environmentally friendly health care system, a review of 2,817 medical colleges in 112 countries revealed that only 15% include teaching about climate change in the curriculum [61].

In 2014, the main approach to professional training identified three learning priorities: It is made of three elements: (a) Knowledge: capacity to grasp the relationship between environment and health at different levels; (b) Skills: science and practice of health resulting in the acquisition of ability and skill towards the promotion, maintenance, and improvement of health systems sustainability in those countries; and (c) Values: recognition of health professional duty in the overall conservation and protection of health under global environmental change [62, 63]. Yet the experience of escalating effects of climate change reveals that theoretical solutions are insufficient to address the problem.

Thus, the given occupational forms facilitate to make the process of education completer and more efficient with the help of the organizational behavior approach based on the practical application of the problem-solving process as the key element of the educational process [64]. The desire for more sustainable development, which is now emerging as an important and global priority, brings up a number of considerations to both teaching and research objectives; on the other hand, there are no obstacles that require their potential solution regarding health professionals and the overall sustainability of the supplying organizations of the health care sector.

The magnitude and complexity of the health sector have made it a major part of most labor-intensive sectors where human resources are central, hence the paramount need to educate health professionals. Climate change results mostly from human activity, thus the success of environmental programs is largely determined on how workers behave [58]. Con-

versely, a major shift should be promoted in healthcare organizations and the healthcare professional leadership role [58], but still nearly two-thirds of undergraduate and graduate health profession education programs carry little or no environmental health component at all to date is required for every practitioner today [65]. Thus, health-care providers frequently are not well-informed in identifying and addressing environmental risks that may have a direct impact on patient health [66]. Moreover, usually there is no training for these individuals to report community-level potential environmental exposures with public health authorities [67].

This lack of preparation has inhibited research progression, access to evidence-based information and the harmonization of international environmental health policies [68, 69]. In these sense, environmental health education has to be a permanent process in order to provide information and literacy [42], as well as awareness-raising so that the individuals of a society become autonomous characters able to control their risk from an ecosocial perspective.

This will require concerted input from many stakeholders, including environmental scientists and public health experts working in conjunction with multidisciplinary research teams as well as local officials and policymakers [42, 70]. By increasing awareness, this toolkit will help reduce the chance of error during encounters between health professionals and patients who may have experienced toxic exposures. Given their contact with communities on a regular basis, they form critical nodes in this network, so investing more in community-based knowledge and skills for health care providers is also important [70].

The emergence of the Covid-19 pandemic a few years ago demonstrated how important it is to have a resilient health system in unprecedented times and at the same time drew attention to changing our way of thinking and behaving for solutions that are more environmentally friendly with involvement from state, organizations, communities as well individual [71].

Unapproachable hospital globally, in order to make a sustainable and environmentally-friendly hospital it is necessary for both the healthcare organization leaders as well as those who work on health that should be applied with an environmental education like the whole environment-based approach [71]. This training must encompass a spectrum of skills and knowledge to better adapt for the more frequent occurrence of extreme weather events by also including emergency management competencies with post- disaster recovery skill set into their curricula [72]. Conversely, involving health workers in debates and simulations around environmental health policy-making can help integrate them into the decision-making process. Short-term workshops and case studies to build community resilience, learn quickly from adapting in-place responses can be used as a toolbox method for supporting communities during disaster situations due to climate change. As such, to meaningfully engage in climate action practitioners must first become better educated on how and where climate change impacts health by integrating units of study into the curricula for various forms of health care.

Establishment of such a competency mapping framework for health and climate change skills leading to their integration in professional curricula, will help prepare the healthcare workforce adequately to face myriad health challenges consequent on climate-change [73]. It is also essential to advance climate education and build capacity for health adaptation with respect to climate change impacts, particularly in low- and middle-income countries that are disproportionately impacted. Measures to bolster inter-sectoral policies could help

realign the involvement of health care providers on a national level within climate action plans, tiering it towards reducing inequality in relation to climate-induced poor-health and enabling widespread improvements in population health [73].

By enabling health professionals to protect the health of populations and capping climate-generated health inequalities, this can push decolonization of international health. Finally, bringing together local and international health organizations on shared learning projects in climate education and climate action will help break the pattern of top-down international health organizations being led by researchers from places like the US or Europe. One way to help there is to make sure that environmental education researchers collaborate with health professors. This kind of collaboration is helpful in putting into practice policy strategies based on scientific evidence, for example encouraging low-emission lifestyles. Health professionals are able to see their role in countering environmental challenges. With better strategies, we will be in a better position to promote sustainability and counter climatic change.

Materials and Methods

This study involved 379 healthcare workers from public hospitals and private clinics in Greece, representing diverse professional roles across Administrative, Medical, Nursing, and Technical Services. The majority of participants (349) were employed in the public sector, underscoring the dominant role of public health services in Greece. The research adopted the stated preference method, specifically the choice experiment technique, to explore in what degree hospital managements take actions for climate change through voluntary initiatives. In addition, it examines how leadership influences staff motivation to adopt environmentally friendly practices and the degree to which healthcare professionals participate in climate change initiatives. A customized 23-item questionnaire was designed, divided into three categories: Organizational Attitude toward Climate Change, Climate Change Initiatives and Green Behavior, and Personal Attitudes and Thoughts on Climate Change and the Environment. Responses were measured on a five-point Likert scale, with Cronbach's Alpha reliability scores ranging from 0.870 to 0.911, indicating high internal consistency. Data collection occurred between November 3, 2022, and February 17, 2023, through Google Forms for public sector employees and personal networks for private sector participants. Statistical analysis was conducted using SPSS Version 26 for Windows, employing descriptive statistics. Due to the nature of the questionnaire, a more extensive completion of the results using tables and frequency diagrams was preferred. After completing the questionnaires, a check conducted for correctness. From the correctness check which was carried out, 100% of the questionnaires were correctly completed.

Results

In our research we examined the role of Organizational Behavior to the Implementation of Sustainable Practices, we also examined in what degree the organizations take actions to reduce the negative impact of climate change. After an extended analysis, we found that, 26.39% (N= 100) of the responders answered that their organizations have already taken

some measures to protect the environment, which shows that there is some activity in this area. In addition, a smaller percentage, 3.17% (N= 12), of responders stated that their organizations consider environmental protection as a priority, indicating that for these organisations environmental sensitivity is a key element of their strategy. However, a 12.7% (N= 48) of the sample report that their organization has not yet taken steps to protect the environment, either due to a lack of planning or other factors. Also, 7.92% (N= 30) say that their organization does not have the financial resources to implement such initiatives, suggesting that cost is a major barrier to adopting environmental practices. Notably, 36.15% (N= 137) of respondents say they do not know whether their organization has taken steps to protect the environment. This indicates a gap in top-down information and awareness around this issue within organisations. Finally, 11.35% (N= 43) state that their organization does not have any policy related to the environment, while a 1.85% (N= 7) said that their organization doesn't consider it necessary to take actions for the environmental protection. Overall, the data shows that while there are organisations that have taken steps to protect the environment, the majority either do not have a clear policy or are not sufficiently aware of its existence. At the same time, cost and lack of priorities appear to be important factors that prevent wider adoption of environmental practices (Fig. 1).

Another important finding was that most of organizations do not dedicate funds to measures and actions to mitigate the effects of climate change (Fig. 2). In particular, only 12.93% (N= 49) of respondents answered positively, a result that suggests that a possible funding to support the circular economy, which is based on waste reduction and resource reuse, it would be extremely limited. A significant 33.25% (N= 126) of responders said that their organization do not dedicate funds for such actions which does not leave much room for a transition to a circular economy model. Particular importance is the fact that 53.83% (N= 204) of respondents do not know whether their organization has planned climate funds. This may indicate a lack of transparency or indifference to the issue, which may have a negative impact on the adoption and promotion of circular economy practices. This trend

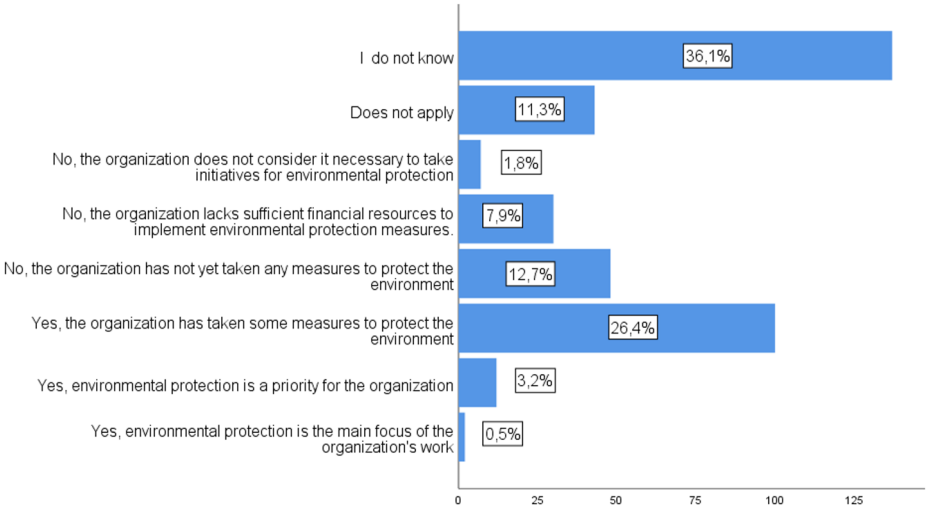

Fig. 1 Bar chart for the question ""The organization I work for has specific policies on climate change"

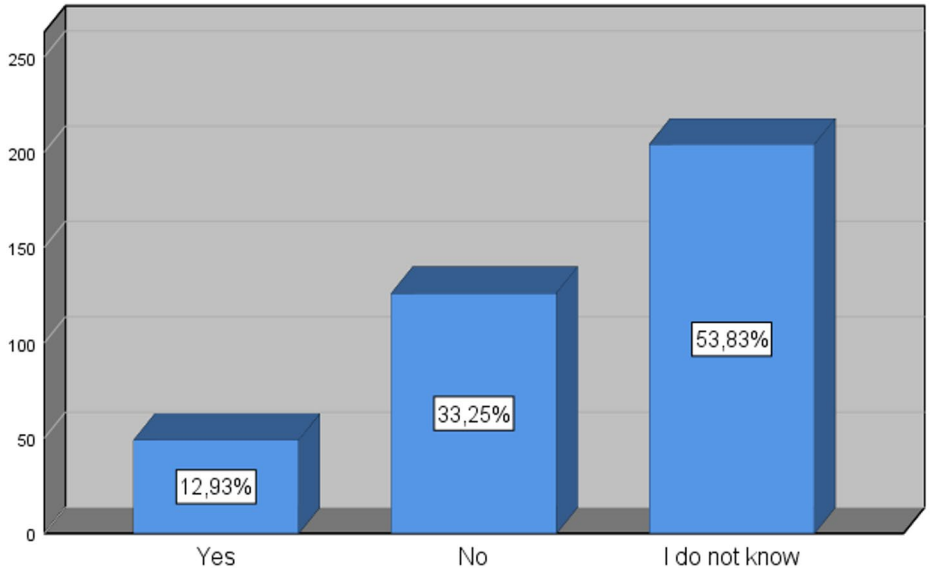

Fig. 2 Bar chart for the question ""My organization dedicates funds to climate measures and actions."

Table 1 Correlation between climate funding and policies

		My organization dedicates funds to climate measures and actions	The organization I work for has specific climate change policies
My organization dedicates funds to climate measures and actions	Pearson Correlation	1	0,354
	Sig. (2-tailed)		,000
	N	379	379
The organization I work for has specific climate change policies	Pearson Correlation	0,354	1
	Sig. (2-tailed)	0,000	
	N	379	379

highlights the need for enhanced information and proactive initiatives at the organizational level in order to integrate strategies that support sustainable circular economy.

From the correlation test of the question above, there is a moderate positive relationship between the two variables while the result is statistically significant (Table 1). This means that when an organization has funds for climate action, it is more likely to implement specific climate change policies.

In the same research, one of the main findings was, the motivation dimension of employees and their active participation in the environmental policies and actions of their organisations was particularly low. More specific, as indicating in the Table 2, the mean values of the responses to the questions were below 3, which suggests that employees have a neutral to negative attitude regarding the alignment of their personal values with the values of the organization, as well as with the environmental actions promoted by the organization. Specifically, the mean value of 2.58 (SD = 1.249) indicates that supervisors do not sufficiently motivate employees to adopt green behaviors. This seems to negatively affect their

Table 2 Descriptive statistics for statements about employee's motivation

My supervisor/manager encourages the staff to adopt more environmentally friendly behavior in their work		All members of the organization are committed to the environmental strategies	My personal values regarding the environment align with the values of my organization	The employees of the organization are excited about the collective effort toward the organization's environmental mission	The culture of my organization allows employees to express their environmental concerns
Valid	379	379	379	379	379
Missing	0	0	0	0	0
Mean	2,58	2,83	2,39	2,66	2,77
Median	3,00	3,00	2,00	3,00	3,00
Mode	3	3	3	3	3
Std. Deviation	1,249	0,968	1,152	0,939	1,064
Skewness	0,174	−0,206	0,213	−0,161	−0,156
Std. Error of Skewness	0,125	0,125	0,125	0,125	0,125
Kurtosis	−1,037	−0,289	−1,026	−0,364	−0,660
Std. Error of Kurtosis	0,250	0,250	0,250	0,250	0,250

active participation in the organization's environmental strategies with a mean value 2.83 (SD =0.968) and creates difficulty in expressing environmental concerns (M =2.77, SD =1.064). The lowest mean value of 2.39 (SD =0,876), which refers to the alignment of personal and organizational values, shows a significant discrepancy, while employees do not express much enthusiasm for the collective environmental mission of the organization (M =2.66, SD =0.939). In conclusion, these low values highlight the need to strengthen environmental culture and leadership to increase employee commitment and enthusiasm towards the sustainability goals of the organization.

Table 3 presents the correlation between environmental leadership, employee values, and engagement in organizational environmental initiatives. The results indicate several significant relationships. A moderate positive correlation ($r = 0.426$, $p < 0.001$) exists between managerial encouragement for greener behavior and organizational commitment to environmental strategies, suggesting that leadership significantly influences collective environmental responsibility. Similarly, a moderate to strong positive correlation ($r = 0.549$, $p < 0.001$) between organizational commitment and employee enthusiasm for environmental efforts indicates that when an organization actively supports sustainability, employees are more likely to be engaged.

Personal environmental values also show strong associations. A positive correlation ($r = 0.498$, $p < 0.001$) between personal values and managerial encouragement suggests that employees who align with environmental principles perceive greater support from leadership. Additionally, the correlation between personal values and employee enthusiasm ($r = 0.509$, $p < 0.001$) reinforces the idea that shared values foster collective engagement.

Conversely, a negative correlation ($r = -0.244$, $p < 0.001$) between participation in voluntary climate action and managerial encouragement, along with a negative correlation ($r = -0.302$, $p < 0.001$) with personal values, suggests that employees who voluntarily engage in environmental actions may feel less influenced by leadership or organizational directives.

Overall, these findings emphasize the significance of leadership and value alignment in fostering environmental commitment while highlighting a complex relationship between voluntary participation and perceived organizational influence.

Lastly, according to the same research that we conducted we found out that the education of the healthcare professionals its crucial in order to achieve any attempt to the path of sustainability in healthcare institutions. According Fig. 3 below, it turns out that the majority of our sample haven't attend a course or training seminar on climate change or environmental management (66.75%, $N = 253$) while the rest answer positive (33.25%, $N = 126$).

The frequency distribution provides insight into the level of agreement among respondents regarding the given statement (Table 4). The largest proportion of participants, (35.9%, $N = 136$), selected "Neither agree nor disagree", indicating a neutral stance on the issue. A significant portion of respondents expressed disagreement, (21.4% $N = 81$) strongly disagreeing and (24.5%, $N = 93$) disagreeing, collectively accounting for 45.9% of the sample. This suggests that nearly half of the respondents hold a negative perception of the statement. Conversely, 18.2% of respondents expressed agreement, with (15.0%, $N = 57$) agreeing and only (3.2%, $N = 12$) totally agreeing. This indicates that a smaller proportion of participants hold a positive view. Furthermore, in organizational level, according to the data in the Table 5, the mean value of the variable "My organization attempts to educate and inform staff about environmental issues" was 2.54 (SD =1.081), which is lower than the neutral

Table 3 Environmental leadership and employee commitment correlation

		My supervisor/manager encourages staff to adopt a greener attitude at work	All members of the organization are committed to the environmental strategies	When my organization volunteers for climate action I am actively involved	My personal values for the environment match the values of my organization	Employees of the organization are enthusiastic about the collective nature of the organization's environmental mission
My supervisor/manager encourages staff to adopt a greener attitude at work	Pearson Correlation	1	0,426	−0,244	0,498	0,429
	Sig. (2-tailed)		0,000	0,000	0,000	0,000
	N	379	379	379	379	379
All members of the organization are committed to the environmental strategies	Pearson Correlation	0,426	1	−0,066	0,423	0,549
	Sig. (2-tailed)	0,000		0,199	0,000	0,000
	N	379	379	379	379	379
When my organization volunteers for climate action I am actively involved	Pearson Correlation	−0,244	−0,066	1	−0,302	−0,240
	Sig. (2-tailed)	0,000	0,199		,000	,000
	N	379	379	379	379	379
My personal values for the environment match the values of my organization	Pearson Correlation	0,498	0,423	−0,302	1	0,509
	Sig. (2-tailed)	0,000	0,000	0,000		0,000
	N	379	379	379	379	379
Employees of the organization are enthusiastic about the collective nature of the organization's environmental mission	Pearson Correlation	0,429	0,549	−0,240	0,509	1
	Sig. (2-tailed)	0,000	0,000	0,000	0,000	
	N	379	379	379	379	379

value of 3, a result that indicate the lack of education for the employees of a healthcare organization, a problem that starts with the culture of the managers.

Discussion

The article emphasizes the gradual identification of useful tools in Circular Economy (CE) principles that can inform hospital managers, particularly in making decisions related to sustainability and environmental stewardship [74]. It underscores the importance of minimizing waste, saving resources, and eliminating environmental burdens within hospital operations. Using CE techniques, such as recycling projects and reusing medical equipment, hospitals can achieve both economic and environmental benefits. These initiatives help reduce costs by minimizing waste collection expenses and the need for fresh resources. The article further highlights how CE adoption encourages managers to think beyond immediate operational issues and align their facilities with long-term sustainability objectives, thereby enhancing the hospital's reputation as a responsible institution. Additionally, it suggests that leadership plays a crucial role in fostering an organizational culture of environmental responsibility, where managers set sustainability targets and encourage circularity among staff. Organizational behavior (OB) and environmental education are also recognized as essential drivers for accelerating the implementation of CE in healthcare organizations, helping shape the culture and behaviors necessary for sustainability practices.

When comparing these perspectives with the results of our research, several key similarities and differences arise, particularly in relation to leadership, organizational behavior, environmental education, and the practical adoption of CE practices in healthcare organizations. In the literature, the leadership role is framed as essential in encouraging staff to align with sustainability goals and fostering an organizational culture that emphasizes environmental responsibility [74]. However, in our research, while 26.39% of respondents report that their organizations have taken steps to protect the environment, a significant 36.15% are unsure of whether any environmental actions have been taken. This suggests a gap in leadership communication and engagement, where top management has not effectively conveyed sustainability goals or integrated them into everyday operations. The lack of clarity and proactive leadership communication observed in our research contrasts with the article's assertion that leadership is central to driving CE practices [75, 76].

Furthermore, the article argues that the integration of CE principles into strategic planning allows hospitals to align their operations with broader social goals, such as a healthier planet [75]. However, the main results of our study, financial constraints emerge as a major barrier to the adoption of environmental practices. Specifically, 33.25% of respondents report that their organizations do not allocate funds for climate change actions, which limits the ability to transition to a circular economy model. This finding highlights the practical challenge of securing the necessary resources for sustainability initiatives, which is not fully addressed in the article. While the literature advocates for the potential economic and environmental benefits of CE [76], our research underscores that, in practice, many organizations are not investing in these practices due to financial limitations.

The literature also emphasizes the importance of organizational behavior (OB) in shaping a culture that supports CE. It suggests that OB can foster a sense of community and collaboration among staff, which is crucial for the adoption of sustainable practices [77]. However,

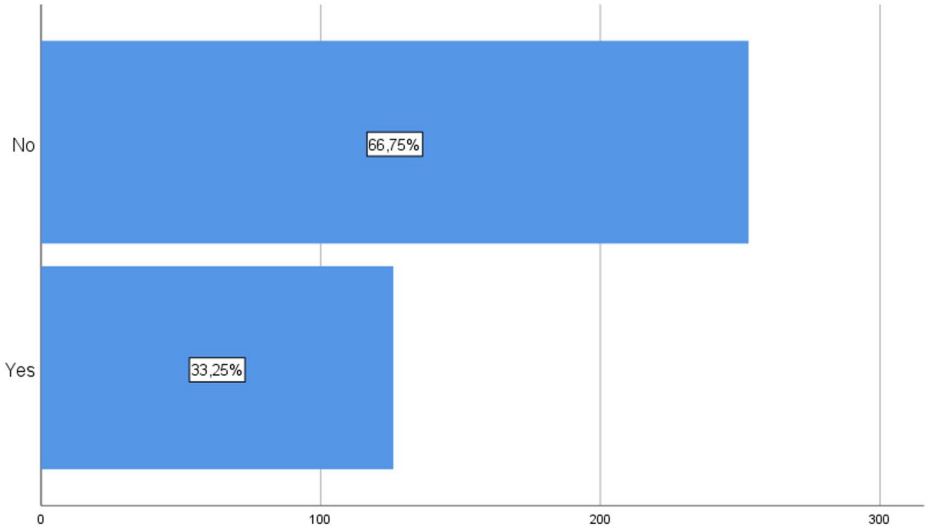

Fig. 3 Bar Chart for the question "I have attended a course or training seminar on climate change or environmental management"

Table 4 Distribution of responses on organizational education about environmental issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	81	21,4	21,4	21,4
	Disagree	93	24,5	24,5	45,9
	Neither agree nor disagree	136	35,9	35,9	81,8
	Agree	57	15,0	15,0	96,8
	Totally agree	12	3,2	3,2	100,0
	Total	379	100,0	100,0	

Table 5 Descriptive statistics for question "my organization attempts to educate and inform staff about environmental issues"

N	Valid	379
	Missing	0
Mean		2,54
Median		3,00
Mode		3
Std. Deviation		1,081
Skewness		0,121
Std. Error of Skewness		0,125
Kurtosis		−0,729
Std. Error of Kurtosis		0,250

our research reveals that the motivation of employees to engage in environmental initiatives is notably low. The mean value for supervisors motivating employees to adopt green behaviors was 2.58 (SD = 1.249), indicating that leadership does not sufficiently encourage staff involvement in sustainability initiatives. This aligns with the article's focus on OB but highlights a key gap: while OB is essential for fostering a sustainable culture, many organizations are not successfully implementing it [66]. The low employee motivation and lack of engagement observed in our research suggest that healthcare organizations need to improve their approach to OB in order to drive active participation in environmental strategies.

Environmental education, as highlighted in the literature, is also identified as a key component for preparing healthcare professionals to implement CE practices [78]. The literature, advocates for mandatory green training to decrease waste and energy consumption, and to ensure that healthcare staff not only understand CE principles but can also apply them effectively [79]. However, our research reveals a significant gap in environmental education. Specifically, 66.75% (N = 253) of respondents reported that they had not attended any training on climate change or environmental management, and the mean value for the variable "My organization attempts to educate and inform staff about environmental issues" was 2.54 (SD = 1.081), indicating a lack of educational initiatives within healthcare organizations. This starkly contrasts with the literature call for comprehensive environmental education [79], suggesting that many healthcare organizations are failing to prioritize training and knowledge dissemination on sustainability issues.

Finally, the literature discusses how motivational theories of behavior change, alongside environmental education, can help design an organizational culture where sustainable practices become integral to operations [80–82]. However, our research shows that organizational practices, particularly in the healthcare sector, are not sufficiently aligned with sustainability objectives. The low levels of employee engagement and motivation, coupled with a lack of financial support for sustainability initiatives, suggest that many organizations struggle to integrate sustainable practices into their culture. This finding underscores the need for more proactive strategies to foster an inclusive and environmentally responsible culture, as well as to provide the necessary resources for the successful implementation of CE models.

In conclusion, while the literature provides a comprehensive theoretical framework for the adoption of CE in healthcare organizations, our research reveals significant challenges in practice. These include insufficient leadership, low employee motivation, lack of environmental education, and financial constraints, all of which hinder the widespread implementation of CE practices. Therefore, while the article outlines the potential benefits of CE, our findings suggest that more proactive efforts are needed to overcome these practical barriers and ensure the successful integration of CE principles into healthcare organizations.

The research offers significant benefits for healthcare institutions by shedding light on the barriers and challenges hindering the full adoption of Circular Economy (CE) principles in healthcare. The key benefits of this research include a clear understanding of the factors affecting CE implementation, such as leadership, employee motivation, environmental education, and financial constraints, as well as identifying areas that require immediate attention. The findings emphasize the need for a systematic strategy that integrates sustainability at the core of healthcare organizations' culture and strategic planning. One of the most important benefits is the highlighted need for enhanced leadership, which should take the initiative to align organizational actions with sustainability goals, effectively communi-

cate CE strategies across all levels, and encourage staff participation. The lack of clear and strong leadership that integrates sustainability into daily operations is a gap identified in the research, providing a starting point for corrective actions. Moreover, the research reveals the need for comprehensive environmental education programs that encompass all healthcare workers, ensuring they understand and adopt CE principles. The lack of environmental education programs focused on climate change and resource management is a significant barrier to CE adoption. Therefore, the research suggests the development of training and awareness programs for staff, aiming to enhance their knowledge and skills in sustainability practices. Financial constraints are also highlighted as a major factor limiting the adoption of CE. The research shows that many healthcare organizations do not allocate sufficient funds for green initiatives and transitioning to a circular economy model. The findings call for a better financial strategy to fund sustainability efforts, either through internal resource reallocation or seeking external funding opportunities. Implementing the findings of this research could lead to substantial benefits, such as reducing operational costs through resource and energy savings, improving the reputation of healthcare organizations as responsible and sustainable institutions, and enhancing public health by adopting environmentally responsible practices. Additionally, integrating sustainability into the daily operations of healthcare systems can yield economic benefits by reducing waste management costs and the consumption of natural resources. Overall, the research provides a practical guide for improving the application of Circular Economy principles in healthcare, suggesting specific steps and strategies to address barriers and achieve sustainable and responsible organizational practices.

Conclusion

As the world faces growing demanding situations from climate exchange and useful resource shortage, healthcare businesses need to undertake sustainable practices to reduce and provide environmental impacts long-time period overall performance has multiplied. Existing literature highlights gaps in understanding the impact of sustainable practices on enterprise and society. To deal with this, healthcare groups around the arena must prioritize sustainability with the aid of incorporating round financial ideas and organizational practices, along with the surroundings by means of promoting environmental focus. Key studies for enhancing CE in healthcare consists of developing included, bendy CE packages for healthcare facilities and inspecting conceptual and organizational dynamics that have an effect on CE adoption This says management styles, worker engagement, and fostering a green organizational subculture. Research on educational programs that include experiential gaining knowledge of with realistic environmental fitness interventions is needed, specializing in powerful coaching techniques and curricula for medical faculty and expert schooling on.

In addition, financial critiques of the price-effectiveness of CE programs, as well as proof-based facts on their effectiveness, are had to exhibit their tangible in depth coverage making in developments, along with medical device recycling, waste era recycling and virtual equipment for the improvement of products and tactics, in which Regulations identifying obstacles, imparting incentives, and engaging stakeholders are important to facilitating CE reform Finally, comparative studies throughout sectors can offer insights into the challenges and opportunities that making use of CE to fitness, tailoring strategies to specific contexts and fostering global collaboration. Addressing those research regions will con-

tribute to sustainable fitness care consistent with CE ideas, sell environmental stewardship, and enhance health outcomes. One main limit of this survey is the small knowledge among groups, especially healthcare workers, about climate change and green growth. This lack of knowledge was a big wall to getting more answers and looking at extra forms for adding in this study. To solve this limit, we want to use more active plans to involve staff which will help us see any changes in thinking about climate change and show real changes that have happened during this time. In future, to get past the time limits, the study could grow beyond the country's border including best ways from European and world level. This would give a chance to do a side-by-side check of Greek health care system with others.

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Data Availability The data are available within this article.

Declarations

Use of AI Tools Declaration The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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