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An Empirical Study on Public Sector versus Third Sector Circular Economy-Oriented Innovations

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Abstract: Extensive research has explored organisational dynamics across various sectors in relation to circular economy (CE) innovation practices. However, a critical gap exists in understanding CE innovation activities in the public sector versus the third sector. This distinction is crucial as the third sector's role in CE innovation is growing, necessitating tailored policies instead of homogenous integration into public sector-based approaches. We address this gap by focusing on nuanced comparisons between the public and third sectors, delving into the motivations and constraints surrounding CE innovations across these different sectors. Employing an exploratory sequential design, we integrate qualitative insights from 12 interviews with quantitative measures derived from 153 survey responses within CE innovation communities. The findings reveal subtle yet significant disparities in innovation activities between the public and third sectors within a CE innovation community. Notably, cost factor differences related to the availability of finance and knowledge factors associated with the lack of information on technology emerge. This research contributes evidence-based insights, offering practitioners and policymakers a nuanced understanding of the motivations and constraints of circular economy innovation. These findings can be instrumental in steering the transition towards a more sustainable and circular economy, emphasising the need for tailored strategies rather than a one-size-fits-all approach.

Keywords: circular economy; public sector; third sector; innovation; regional innovation



Citation: Clifton, N.; Kyaw, K.S.; Liu, Z.; Walpole, G. An Empirical Study on Public Sector versus Third Sector Circular Economy-Oriented Innovations. *Sustainability* **2024**, *16*, 1650. <https://doi.org/10.3390/su16041650>

Academic Editor: Antonio Boggia

Received: 15 December 2023

Revised: 3 February 2024

Accepted: 5 February 2024

Published: 17 February 2024



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1. Introduction

The circular economy (CE) represents a paradigm shift in how we produce and consume goods and services, aiming to minimise waste, conserve resources, and promote sustainability [1]. The CE concept has been subject to multiple definitions and has served as an emergent approach to industrial production and consumption [2]. The [3] (p. 19) views CE as 'restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times'. Thus, the transformation towards a CE represents innovation in the form of new processes, product development, service solutions, and business models [4], as well as developing organisational innovation capabilities [5]. Indeed, the implementation of CE principles has been addressed in recent years, as these approaches promote intra and inter-organisational learning [6,7] and enhance organisational innovation capabilities [5,8]. For instance, via decarbonisation and waste reduction projects, organisations can adopt new processes and technologies, realising new product and service solution opportunities. Simultaneously, communities of practice (CoP) [9] involving practitioners from various industry sectors sharing knowledge and best practices together have been formed. This approach is helpful in advancing CE innovation at organisational and regional levels [7]. Thus, an understanding of CE-oriented

innovation has become imperative to achieve economic benefits as well as sustainable development [7]. In this paper, we regard CE-oriented innovation as the organisational-level practice of CE principles, for example, designing waste and pollution out of systems, keeping products and materials in use, and regenerating natural systems [3], which can lead to new products, processes and business models. In other words, CE principles serve as innovation approaches, whereas innovation activities eventually realise CE goals.

CE-oriented innovation has been explored primarily in the context of the private sector, predominantly within manufacturing companies [10]. Conversely, there is a paucity of research on public and third-sector CE innovation [11], which have their unique features and constraints [12–17]. Both the public and third sectors will play a vital role in supporting the transition to a CE, not least as third-sector organisations are increasingly charged with the delivery of initiatives and outcomes previously the responsibility of the public sector [18]. However, public and third-sector organisations operate within distinct frameworks that necessitate a nuanced understanding of differences in their unique challenges and opportunities. For example, public sector organisations may be more risk-averse due to public scrutiny and political considerations, which can constrain innovation. In contrast, third-sector organisations pursue a social mission, and changes in funding cycles may facilitate agility and innovation [19]. These different motivations, challenges, and practices suggest that their approaches to adopting CE innovation should be evaluated to facilitate, ultimately, more tailored CE policy delivery. While considerable research has examined the innovation activities and CE practices in organisations [5,20–24], there is a lack of research on innovation activities in the public versus third sector within a CE innovation community framework. As a result, differences in innovation activities and factors influencing innovations in public sector versus third sector organisations remain ambiguous.

Recognising the nuances in public sector versus third sector organisations is essential for optimising their efforts and fostering a synergistic approach to CE innovation. An understanding of the differences in innovation activities between public and third-sector organisations in the context of the CE is crucial for achieving the collective goal of a more sustainable and circular future for several important reasons. Innovation often involves a degree of risk, and the ability to manage and learn from failures is a key component of successful CE initiatives [25]. Public sector organisations often have a broader reach and capacity for scaling CE innovations, but they may face bureaucracy and resource limitations (see, for example, [18,26]). Third-sector organisations, on the other hand, may excel in developing innovative solutions but struggle with scalability and replication. A better understanding of the differences between these sectors can inform strategies for effectively disseminating successful innovations, informing policymaking by providing evidence-based insights, enabling more effective resource allocation, and helping shape the policies that will drive the transition to a more sustainable economy. These insights help formulate policies tailored to each sector's specific needs and challenges to ensure their effectiveness. Research on this distinction can provide evidence-based recommendations for policymakers and practitioners so they can make informed decisions on how to allocate resources to maximise impact.

Based on the outlined research, this study presents findings from empirical data collected on the innovation activities of organisations that participated in a CE innovation community of practice. By combining qualitative analysis based on interviews and quantitative analysis based on surveys, we empirically investigate the barriers and enablers of innovation activities, process and product innovations, innovation collaboration and partnerships and innovation management across the different sectors.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature on public-sector and third-sector CE-oriented innovation. Section 3 outlines the research methods employed. Section 4 presents the results from qualitative and quantitative data analysis and discusses the corresponding results. Section 5 provides some conclusions and presents suggestions for future research.

2. Literature Review

2.1. Circular Economy-Oriented Innovation

The transition towards a CE involves innovation activities and enhances organisations' innovation capabilities [5]. Accordingly, most innovation activities are observed in the forms of eco-design business models, product design, product leasing, and collaboration [5,10]. The principles to achieve a CE are often referred to as reduce, reuse, recycle, and recover resources [3], which is an innovation process for sustainable development [8].

In addition, circular business models concern the retaining of economic value while moving towards a CE [3,4,27,28]. Among them are the Product-Service System (PSS)-based model [27,28] and the ReSOLVE framework, the latter representing the acts of regenerate, share, optimise, loop, virtualise, and exchange [3]. For instance, a recent study based on multiple cases has employed the ReSOLVE framework to measure the maturity of CE innovation cycles [4]. This demonstrates that CE transformation can result in business model innovation and thereby enhance organisational innovation capability [5].

It is also recognised that CE-oriented innovation relies on collaborative learning [6,7]. This can be investigated using the theoretical lens of a community of practice, defined as 'groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis' [9] (p. 4). Communities of practice are often formed around shared passion and expertise, and they can promote knowledge-sharing and collaboration [6,29]. For instance, drawing upon a study on a publicly funded community of practice, it is proposed that interaction among universities, public services, the third sector, and government can lead to the co-creation of new knowledge and advance the regional innovation system [7].

2.2. Public Sector Innovation

Whilst CE innovation is explored in the private sector, public sector innovation studies have identified a range of key issues that have transformative implications for the functioning of public organisations [30]. These issues encompass the definition and conceptualisation of innovation in the public sector, the factors driving or inhibiting innovation, and the essential role of leadership and organisational culture [31]. In recent years, a growing emphasis has been placed on the importance of open and collaborative innovation involving various stakeholders [32], digital transformation [33,34], and the evaluation of innovation efforts to ensure effectiveness [35]. Additionally, the challenge of fostering a culture of innovation and inclusivity within the public sector has become a central theme [36], reflecting the imperative for governments to adapt and respond to changing societal needs.

One fundamental challenge in public sector innovation studies is the conceptualisation of innovation [37]. Unlike the private sector, where innovation often takes the form of new products or services [38], public sector innovation encompasses a broader spectrum, including policy innovation, process innovation, and social innovation. The public sector's role as a provider of public goods and services necessitates a rethinking of what constitutes innovation in this domain [39]. Moreover, understanding how innovation in the public sector differs from that in the private sector is crucial for effective policy formulation and implementation [40]. This issue highlights the need for a nuanced understanding of public sector innovation that considers its multifaceted nature [20].

The drivers and barriers of public sector innovation are multifarious and often interrelated [41,42]. The literature emphasises the pivotal role of the lack of resources, including financial resources and human resources, in shaping the innovation landscape within public organisations [43,44]. Lack of access to resources, such as funding constraints and limited utilisation of financial services, have been reported as important barriers to public sector innovations [45,46]. Uncertainties arising from perceived risks and lack of information associated with technology and market environments can act as barriers as they can limit engagement in innovation activities [47–49]. Regulatory requirements are another potential factor that affects innovation activities in the public sector, as risk-averse or bureaucratic organisations can impede innovation efforts [14,50]. These challenges underscore the com-

plexity of the public sector innovation landscape and the need for multifaceted strategies to overcome them.

In recent years, the emergence of open and collaborative innovation has become a significant issue in public-sector innovation studies [51]. This concept involves engaging external stakeholders, such as citizens, businesses, and third-sector organisations, in the innovation process [36,52]. Open innovation can enhance the effectiveness and relevance of public services, drawing on collective intelligence and diverse perspectives [53]. Open innovation strategies, often facilitated by digital platforms and technology, can enable governments to co-create solutions with citizens and tap into external expertise [54,55]. The challenge lies in establishing effective mechanisms for collaboration, addressing concerns of data privacy and security, and ensuring that open innovation efforts are inclusive and accessible to a diverse range of stakeholders [56–60]. This issue reflects the evolving landscape of public sector innovation, emphasising the need for government to be more responsive and collaborative in addressing complex societal challenges.

2.3. Third Sector Innovation

Compared to the public and private sectors, innovation in the third sector is underexplored in terms of the innovation adoption patterns and implementation processes [61,62]. Due to the nature of the third sector, often interchangeable with the term voluntary sector [63], its innovation contributes to ethical investment [64] and socially and environmentally responsible business practices [61,65]. The sector faces the challenges of increasing service demand and resource limitation [16]. Accordingly, studies on third-sector innovation are linked to the concepts of social innovation [16,66,67] and service innovation [68], the former meaning to provide ‘new solutions to a social problem that is more effective, efficient, sustainable or fair than existing ones and which has the capacity to accumulate value created in society as a whole’ [69] (p. 36). This is further highlighted in a recent conceptual study indicating a multi-agent co-creation of novel services by citizens, social entrepreneurs and third-sector organisations in the innovation process [70].

Studies on civil society organisations, a subset of the third sector, show innovation constrained by variation in vision and financial resources [15]. Incentives for Non-Governmental Organisation (NGOs) and the individuals working in these organisations are vital to the effectiveness of innovation [71]. Among the third sector are also social enterprises, which play a key role in local economies [17] and demonstrate a bottom-up innovation approach with multi-stakeholder engagement [67]. In fact, many mission-driven social enterprises are engaging in CE activities, e.g., reuse, upcycling, refurbishing or repair at the neighbourhood and city scales, fostering the development of the CE into a localised interconnected material and social relations [11,72,73]. However, the role of social enterprises in CE transformations is overlooked by the literature [11].

Based on a three-round Delphi study of Wales-based social enterprises, ref. [17] identify fourteen challenges social enterprises face in terms of innovation and growth, the top five being finance, leadership, commercial viability, social value, professionalisation of marketing, and perception of validity. Recent studies also show a trend of exploring partnerships between public and third sectors for service innovation [68]; these two sectors can complement each other [74], whereby innovation can be built upon mutual resource dependencies [75].

2.4. Identification of the Research Gaps

The above literature has laid an important theoretical foundation for the understanding of CE-oriented innovation [3,27,28]. Nevertheless, there are some gaps. Firstly, the concept of the CE is explored mainly from the private sector and in the context of manufacturing companies that deliver tangible products [10]. However, public and third sectors deliver services and are constrained by specific challenges, for instance, financial and regulatory (public sector) [12–14] and funding and commercial viability (third sector) [15–17]. This

makes CE-oriented innovation in the two sectors different from that of the private sector, and this is underexplored in the current literature [11].

Secondly, extant literature has addressed the role of communities of practice in fostering a regional innovation system at a macro level, which involves interaction among university, public sector, private sector, third sector and government actors [6,7,9,29]. However, there is limited study at a micro level in the innovation system [76], and the current literature has not addressed the differences in innovation activities between public and third-sector organisations in the context of CE-related innovation communities.

Thirdly, innovation in the public and third sectors demonstrate different foci. Public sector innovation studies focus on the conceptualisation of innovation, drivers and barriers to innovation, and open innovation [31,32,42,59]. On the other hand, third-sector innovation is often linked to social innovation and service innovation [16,66–68,70]. Current literature indicates that public sector organisations may be more risk-averse due to the public's scrutiny and political considerations, whereas third-sector organisations may be more agile and willing to experiment due to resource constraints [14,17,50]. Though there are studies on partnerships between the two sectors for innovation [68,74,75], there is limited understanding of the differences in CE-oriented innovation activities between them. This understanding is salient for ensuring that limited resources in each sector are used efficiently to drive CE objectives (see, for example, [77]). Thus, a comparative study of these two sectors in terms of the degree of innovation risk and the ability to manage and learn from failures is key to the success of CE-oriented innovation more generally [25].

Our study seeks to fill a gap in the literature; that is, the current understanding of CE-oriented innovation in the public and third sectors is insufficient, and the different CE-oriented innovation motivations, activities, and challenges in these two sectors are underexplored. The need to advance this knowledge arises because whilst the third sector is increasingly playing a crucial role in CE-oriented innovation, there is a risk of categorising it within innovation policies designed for the public sector, and it is imperative to move away from universal policies and adopt a more nuanced approach, taking into account the distinctions we pinpoint in this context. Accordingly, we ask the following research question:

How do the factors influencing innovation activities differ between public-sector and third-sector organisations in a circular economy-oriented innovation community context? (i.e., our aim is to investigate the relative degree of importance of each of the key factors influencing innovation activities in a comparative context between the public sector and third sector to inform practitioners and policy makers in designing more strategically focused resource allocations tailored to each).

3. Research Methodology

3.1. Research Context

To compare the innovation activities of the public sector versus the third sector in a CE-oriented innovation community, we engaged with the Circular Economy Innovation Communities (CEIC) project based in Wales, UK. Started in 2021, CEIC is a 3-year project funded by the European Social Fund, designed and delivered jointly by Swansea University and Cardiff Metropolitan University to support organisations to develop new service solutions to enhance productivity and deliver CE benefits. The programme comprises a network of practitioners, specifically public- and third-sector service managers.

Each cohort of the CEIC programme lasts for ten months, and activities include monthly workshops to develop innovation skills and build strong networks to support innovation plan development, R&D support from WRAP Cymru (WRAP works with governments, businesses, and communities to deliver practical solutions to improve resource efficiency around the world <https://wrapcymru.org.uk/> (accessed on 14 December 2023)) and University staff, and one-to-one mentoring support. CEIC facilitators form each cohort into an interorganisational community of practice, with participants working in small groups of five people. Participants then work collaboratively on a specific challenge, e.g.,

decarbonising social housing. Via on-going workshops, stakeholder engagement, and fieldwork, they learn innovation methods and tools (e.g., ReSOLVE) that can deliver CE benefits. Using iterative learning approaches, each group eventually develops a prototype or new service solution and presents it at the end of the programme to Wales's public, private and third sectors in a conference setting.

By October 2023, CEIC had delivered fourteen cohorts consisting of 185 participants from 80 organisations. This includes seven cohorts in the Swansea Bay Region and seven cohorts in the Cardiff Capital Region. The cohorts in the Swansea Bay Region consist of 103 participants (82 from the public sector and 21 from the third sector). The cohorts in the Cardiff Capital Region comprise 82 participants, of whom 66 are from public sector organisations and 16 from the third sector. Though each programme ended after 10 months, participants were still connected through CEIC events and social media, and further developed innovation plans that can be implemented and signposted to innovation funding. Tangible projects, such as utilising Welsh wool for insulation in the local housing sector and developing a new sensor in the water supply, are currently in progress. Thus, the CEIC case provides an appropriate setting to answer the research question.

3.2. Research Method

To answer our research question, we applied a mixed methods research design to gain a more comprehensive understanding of an emerging phenomenon [78]. We adopted an exploratory sequential design, which starts with a qualitative study and then uses the results thereof to build quantitative measures for further analysis [78]. Specifically, we first conducted a qualitative study to initially identify key themes relating to CE-oriented innovation in the public and third sectors. Following this, the quantitative method further developed the instruments to verify the correlations between the detailed factors and compare the differences between the sectors.

The qualitative method relies on an interpretive approach to explore new theoretical insight into organisational practice [79]. In this study, we aim to understand the important themes relating to CE-oriented innovation. Semi-structured interviews were adopted to collect qualitative data [80]. Qualitative sampling requirements [81] included the following: (1) the interviewee has actively engaged in the CEIC community; (2) he/she works at public or third sector organisations; (3) the interviewee is in a senior management position and can influence the decision making at their organisations; (4) there has been CE principle implementation ongoing at the organisation due to the participation of CEIC; (5) there is good access to the data. This resulted in our engagement with twelve CEIC participants between January 2022 and March 2023 using semi-structured interviews. Among them, seven interviewees were from public sector organisations, including the Health Boards, NHS departments, and local councils (referred to as P1, P2, . . . , P7). Five interviewees were from third-sector organisations, including social enterprises, charities and housing associations (referred to as T1, T2, . . . , T5). Each interview lasted around 40 min, generating a transcript of 3500 words on average. Interview questions were developed based on the literature related to CE elements [3], innovation process [3,8] and business model [3,4,27,28]. Sample questions included '*When and why did you join the CEIC programme? What are the prioritised areas?*' (CE-element-related questions), '*What happened since you joined the programme? Any major changes in your product/service design and daily operations process?*' (process-innovation-related questions), '*What worked? What hindered the realisation of CE innovation in your organisation? How do you share CE practice with others?*' (business-model-innovation-related questions). In addition, there were questions tailored to the organisational context. We then followed the thematic analysis process [81,82]. First, interviews were recorded and transcribed. Second, each researcher developed coding and evidence independently. Third, all researchers worked together to compare and agree on the coding, ensuring data triangulation [81]. Fourth, the main findings were generated by the researchers jointly. They were interpreted and compared to prior research. Fifth, we continued this process until saturation and confirmed the final theoretical themes [81,82].

In the second stage of the mixed methods research design [78], we applied a complementary quantitative method. A survey questionnaire (see Appendix A) was developed based on the literature review and qualitative interviews, undertaken online using the Qualtrics tool from March to April 2023. The participants were asked the extent to which distinct factors were important as barriers or constraints to their innovation activities over the last three years.

The constraint factors were categorised into four broad areas comprising cost factors, knowledge factors, market factors and other factors [20,77,83]. The cost factors were further disaggregated into the availability of finance, direct innovation cost, perceived economic risks and cost of finance. The knowledge factors were divided into the lack of qualified personnel, lack of information on markets and lack of information on technology. The market factors consist of market dominance by established businesses and uncertain demand for innovative goods or services. Other factors were further divided into the UK regulations, EU regulations, and preparations to leave the EU (Brexit). Overall, 153 valid responses were obtained, representing a response rate of approximately 80 per cent of all eligible respondents. The respondents were managers, team leaders, directors, chief officers, heads, advisors, business partners, coordinators, assistant managers, deputy heads, inspectors, councillors, clinical scientists, advanced practitioners, and sustainability champions. Each of the aforementioned factors was further delved into with respect to the degree of importance by asking the participants to respond based on high, medium, low, or not-experienced factors. Thus, the quantitative empirical data complemented qualitative interviews in this research and provided further insight into the study.

4. Results and Analysis

4.1. Qualitative Data Analysis

Following the thematic analysis [81,82] process described in Section 3.2, we developed initial codes from the 12 interview transcripts. As shown in Table 1, the codes reflect the important motivations, attitudes and practices relating to CE-oriented innovation according to public sector interviewees (P1, P2, ..., P7) and third sector interviewees (T1, T2, ..., T5). These include, for instance, 'new project/prototype based on CE', 'CE projects should consider financial return'. Initial codes are further analysed and categorised according to their similarities and differences, resulting in the categorisation in terms of 'cost reduction', 'project advancement', 'knowledge sharing', 'mindset change', 'knowledge insufficiency', 'funding difficulty'. Eventually, by actively engaging with the categories, discussion, and confirmation among the researchers, two themes were generated: 'motivation of CE-oriented innovation' and 'constraints of CE-oriented innovation'. Table 1 presents the structure of the qualitative data.

Theme One: Motivations of circular economy-oriented innovation.

As shown in Table 1, Theme One concerns the motivations of CE-oriented innovation, which is evident in terms of cost reduction, project advancement, and knowledge sharing.

The interview data demonstrates a positive shift towards developed CE practice due to their participation in the CEIC project. Among the motivations for CE-oriented innovation is cost reduction, interpreted by the interviewees as the reuse, repurpose, and recycle process, which can save material cost-effectively (P1, P4, P5, P6, P7, T5). Such practice is conducted in various aspects, including product design, packaging, transportation, production, supply chain, etc. This shows waste reduction continues to be prioritised in CE-related practice, which can lead to cost savings in the long term [3,8]. Additionally, it is highlighted by the public sector interviewees that there is a general need in the sector to reduce the cost of procurement and transportation whilst transforming towards a CE, which is also promoted by the Welsh Government (P2, P4, P5, P6, P7). The emphasis on procurement has been seen in public-sector-related research, however, from a legal configuration rather than a cost perspective [84]. As the data show,

'Within the public sector, the biggest priority is financial savings and to some extent, in the past we've looked at schemes that can reduce carbon, but they typically come at a cost.'

Now that is transitioning slightly in that... electric vehicles, now it's got to the point where you can run electric vehicles far cheaper than you can run internal combustion engine vehicles. So the market is changing. So that's been very positive.'—P4

Table 1. Qualitative data structure.

Evidence/Initial Code	Categorised as	Contributing to
Reduce procurement and transportation cost (P2, P4, P5, P6, P7)	Cost reduction	
Recycle and reuse materials to save cost (P1, P2, P5, P7, T1, T3, T5)		
Existing-sustainability-/circular-economy-related projects (P1, P3, P7, T3)		
New project/prototype based on circular economy (P1, P2, P4, P6, P7, T1, T3, T4, T5)	Project advancement	Theme One: Motivations of circular economy-oriented innovation
Developing plans for circular economy/decarbonisation training (P2, P3, P6, T3)		
Understand circular economy from various perspectives (P2, P4, P5, P6, T2, T3, T4, T5)		
Share best practice and practical process/tools (P2, P3, P4, P5, T1, T2, T4)	Knowledge sharing	
Network including with other sectors (P1, P2, P3, P4, P5, P6, P7, T1, T2, T3, T4, T5)		
People are afraid of trying new things and failure (P1, P2, P3, P5, P6, P7, T2, T3)		
Work in silo without communication or sharing (P1, P2, P3, T3, T5)	Mindset change	
Bureaucracy and requirement for leadership (P2, P4, P5, T2)		
Circular economy is too wide and not linked to a specific organisation (P2, P4, P7, T2, T3, T4, T5)		Theme Two: Constraints of circular economy-oriented innovation
There is no standard circular economy innovation procedure to follow (P3, T2)	Knowledge insufficiency	
Circular economy projects should consider financial return (P6, T5)		
Lack of funding also due to regulations and market reasons (T1, T2, T3, T4, T5)	Funding difficulty	

Additionally, some participants were passionate about CE-oriented innovation due to their roles as sustainability managers. Some have conducted sustainability related projects before (P1, P3, P7, T3) or wanted to advance new projects (P1, P2, P4, P6, P7, T1, T3, T4, T5). For instance, P1 has already led a project to regenerate 55 acres of land for health board development under green infrastructure, e.g., using land to grow vegetables. P1 obtained Welsh government support for the reuse of hospital beds for charity purposes. Similarly, inspired by tools and knowledge introduced by CEIC, P2 started a commission to encourage health boards to improve the environment via art projects based on reusable, recyclable and repurposed materials. Plans including carbon literacy training programmes have been launched due to participation in CEIC (P2, P3, P6, T3). T1 has designed a new house insulation solution using local Welsh wool, whereas T5's organisation has developed a sensor prototype to monitor water quality via collaboration with other CEIC members. In doing so, practitioners have delivered new projects that implement circular economy principles, adopt cleaner ways of production, provide sustainable solutions, and enhance local supply chains, demonstrating CE-oriented innovation. The impact of managers on organisational change can be linked to leadership, which can be developed via the engagement of CoP [85]. However, the relationship between leadership and CE innovation is only briefly discussed in the current literature [86].

Moreover, knowledge sharing was highlighted by all interviewees, which provided a foundation for CE-related innovations. This primarily confirms the argument in the literature that a CoP as situated practice serves as a source of knowledge formation [87]. Specifically, as the CE is an evolving concept, participants can benefit from co-defining a common challenge, e.g., decarbonisation, and co-creating a solution together (P2, P4, P5, P6, T2, T3, T4, T5). This means participants not only absorb knowledge from the CoP but also contribute to the CoP by creating new knowledge. Additionally, they learn from other sectors and share best practices (P2, P3, P4, P5, T1, T2, T4). This can also prevent other organisations from making the same mistakes (T1). There is an interest in developing knowledge in a practical way (P5). Such cross-sector and cross-discipline knowledge sharing is under-studied in the CoP literature [7]. Furthermore, participants are actively exploring collaboration opportunities and sharing information via social media even after completing the CEIC programme (P1, P2, P3, P4, P5, P6, P7, T1, T2, T3, T4, T5). As reflected in the interview,

'It made sense for me to continue to broaden my own personal knowledge of what NET Zero is, what sustainability is, what this idea of a circular economy was, which was pretty new to me in that aspect...when it comes to the circular economy aspects, there was an awful lot I didn't understand and simply reading material on it wasn't enough.'—P5

Theme Two: Constraints of circular economy-oriented innovation

As Table 1 indicates, Theme Two concerns the constraints of CE-oriented innovation. Details include mindset change, knowledge insufficiency, and funding difficulty.

Mindset change is urgently needed, according to the interviewees, which applies to both individual and organisational levels. This is because when people work in silos, it is difficult to implement CE principles which require teamwork and collaboration (P1, P2, P3, T3, T5). While current literature on CE-oriented innovation focuses on tools, processes, and techniques, the soft side of innovation management, e.g., mindset changing and systematic thinking, is underexplored [88]. The CE is a relatively new concept to most organisations, and thus, it can be hard for senior management to adopt changes (P2, P4); there can be bureaucratic and ingrained attitudes (P5). Leadership is needed to coordinate a region- or industry-wide resource (T2). Moreover, CE transformation is across departments, and mindsets such as fear of failure hinder innovation attempts (P1, P2, P3, P5, P6, P7, T2, T3). The interview data show,

'A lot of organisations are very risk adverse. They are wary. And they went to insure with this good governance around things. People are afraid of failure. And I think it's trying to get people to be bold and to be brave and realize, you know, and I'm sure that there will be things...you know, I'm not afraid to try something new, but then it's also accepting...you might do something. It might fail. However, that's OK.'—P1

Whilst knowledge sharing is the main motivation of CE-oriented innovation, the interview data show knowledge insufficiency as a barrier to the implementation of CE principles. This theme has been broadly discussed in the public sector as a resource constraint- a lack of information associated with technology and market environments, which can hinder innovation activities [47–49]. Nevertheless, the literature has not addressed innovation limitations due to knowledge insufficiency in terms of the CE. There is, in general, a lack of awareness of CE principles because the concept is ambiguous and not linked to specific departments or daily work contexts (P2, P4, P7, T2, T3, T4, T5). This happens at both individual and organisational levels, as the CE remains a new concept without clear elements or processes to follow. Furthermore, CE-oriented innovation has different meanings to different sectors, and thus there is no standard procedure to follow (P3, T2). For instance, a third-sector interviewee highlights that CE practice can be difficult to transfer,

'It's (circular economy) just too large, and it is too wide...a solution that that useful for North Wales is not necessarily going to be applicable for South Wales...as an organization, I don't think we...we not at a position to define or even understand what circular economy

actually means or could mean... for the organisation at the moment it would take some time.'—T2

Funding and investment difficulties are other constraints. One public sector interviewee (P6) highlighted the challenges of investment after the pandemic, suggesting that decarbonisation projects should be combined with a clear revenue plan. Funding limitation is emphasised by the third sector as a major challenge (T2, T3, T4, T5). This is also due to regulations, including charity laws (T4, T5). Some new CE solutions are being implemented, and yet their impact is not widely understood (T1, T5), which makes securing funding support challenging. The data support suggestions in the literature that regulation is a constraint to public sector innovation [40], whilst the data suggests the main challenge to CE innovation in third-sector organisations is funding scarcity [17]. To overcome the challenges, our data suggest that collaborative funding applications could mitigate this barrier:

'Financial support (is challenging) because often those innovations are quite expensive... it would be useful to map all the initiatives going on in Wales at the moment and all the learning that's happening, and I know that that's tricky when there's different local authorities competing for different funding...but I think a better approach is to sharing learnings and understandings and what's worked and what hasn't in order to kind of implement progress more widely across Wales and to not waste time and to not waste resources as well because, you know, we're...circular economy is all about sharing.'—T3

4.2. Quantitative Data Analysis

As discussed in the preceding qualitative data analysis, the themes related to cost reduction (cost factor), project advancement (market factor), knowledge sharing (knowledge factor), mindset change (knowledge factor), knowledge insufficiency (knowledge factor) and funding difficulty (cost factor) emerged from the qualitative study. In the survey, other potential constraining factors related to regulations were also included in addition to the cost factors, knowledge factors and market factors for more comprehensive coverage, as the literature suggests the importance of regulatory constraints (see, for example, [47,89]). Other constraining factors were also informed by the literature; for example, resource dependency theory posits that organisations are dependent on external resources, and their ability to achieve their goals, such as investments in innovations, is contingent on their financial resources [5,90,91]. As this theory suggests a key role of financial constraints on the capacity of organisations to implement CE-oriented innovations, it points to various cost-related constraining factors such as the availability of finance, direct innovation cost, perceived economic risks, cost of finance also, knowledge-related constraints such as the organisations' ability to recruit qualified personnel and acquire and utilise information on markets and technology; and market-related factors such as entities' ability to compete with large institutions, and respond to demand for CE initiatives. The theory proposed by [92] also sheds light on the role of transaction costs on cost-related constraints, such as the availability of finance and other constraints including regulatory factors, as the costs pertaining to coordination and administrative activities within bureaucratic organisations can contribute to higher transaction costs associated with compliance with new CE regulations. These factors are also in line with the absorptive capacity theory, which helps understand an organisation's ability to recognise, assimilate and apply new knowledge [93]. For instance, ref. [94,95] assert the significant role of absorptive capacity for the cost and knowledge factors. Results were obtained from the analysis of the 153 usable respondents (96 from public sector organisations, 57 from the third sector) in relation to the constraints to CE-oriented innovation activities or those influencing a decision not to innovate.

The results summarised in Table 2 indicate that while the availability of finance is consistently highlighted as the most significant constraint to CE-oriented innovations in both public- and third-sector organisations, it is more of a hindrance in third-sector organisations. This finding is supported by the interview results, which highlight the difficulty in obtaining funding and underline the need for financial support in third-sector

organisations (T1, T2, T3, T4, T5). While both public sector and third sector organisations play pivotal roles in driving CE-oriented innovation, the availability of finance emerges as a more significant barrier for the latter. This may be due to third-sector entities often experiencing a lack of financial autonomy enjoyed by public-sector organisations [96,97]. This is in line with resource dependency theory, which points to public sector organisations having direct access to public funds, which enables them to invest in CE initiatives without facing the same financial constraints as third-sector entities, which rely on fundraising and donations. Third-sector organisations, subject to the dynamics of voluntary donations and grant availability, may face greater uncertainties in maintaining consistent financial support for CE-oriented projects.

Table 2. Cost factors: Degree of importance.

Cost Factors	Sector	High	Medium	Low	Factor Not Experienced	No Answer	Total
Availability of finance	Public	28 (29.20%)	24 (25.00%)	03 (03.10%)	21 (21.90%)	20 (20.80%)	96 (100.00%)
	Third	22 (38.60%)	13 (22.80%)	05 (08.80%)	07 (12.30%)	10 (17.50%)	57 (100.00%)
Direct innovation cost too high	Public	19 (19.80%)	23 (24.00%)	03 (03.10%)	28 (29.20%)	23 (24.00%)	96 (100.00%)
	Third	12 (21.10%)	12 (21.10%)	09 (15.80%)	09 (15.80%)	15 (26.30%)	57 (100.00%)
Excessive perceived economic risks	Public	16 (16.70%)	20 (20.80%)	06 (06.30%)	30 (31.30%)	24 (25.00%)	96 (100.00%)
	Third	11 (19.30%)	11 (19.30%)	11 (19.30%)	09 (15.80%)	15 (26.30%)	57 (100.00%)
Cost of finance	Public	16 (16.70%)	24 (25.00%)	03 (03.10%)	31 (32.30%)	22 (22.90%)	96 (100.00%)
	Third	08 (14.00%)	14 (24.60%)	08 (14.00%)	11 (19.30%)	16 (28.10%)	57 (100.00%)

The funding challenge chimes with research that identifies the financial vulnerability of third-sector organisations as a barrier to CE innovation [98,99]. The study emphasises that these organisations are particularly susceptible to fluctuations in funding, making it challenging to sustain long-term CE initiatives. Public sector organisations, on the other hand, benefit from more stable funding sources, which can provide a secure financial base for CE innovation. Third-sector organisations often rely on a diverse set of funding sources, including philanthropic donations and grants, and yet securing adequate and stable funding for CE projects remains a common challenge. Finance is a more critical barrier for third-sector organisations in CE innovation projects as they often involve collaboration with various stakeholders (businesses, government bodies, and research institutions). Transaction costs, such as negotiation, monitoring, and enforcement, are integral to these collaborations [100]. In accordance with transaction cost theory, public sector organisations, due to their scale and authority, may be better equipped to absorb and manage such costs. Conversely, third-sector organisations, often smaller and less well-funded, struggle to cover these costs, hindering the development and implementation of CE innovation. Since CE innovations require substantial initial investments in research, development, and infrastructure, public sector organisations can absorb the upfront costs more easily. Policymakers should consider these financial challenges when designing support mechanisms to enhance CE innovation in third-sector organisations.

Moreover, the results point to the direct innovation cost and perceived economic risks as greater constraints to third-sector organisations, but while the cost of finance is a substantial constraint to innovation activities in both the public sector and third sector, it is a more constraining cost factor in public sector entities.

The survey result on the direct innovation cost, consistent with the interview data, highlights obtaining funding difficulty (T1, T2, T3, T4, T5) in Table 1, which may be because of the financial constraints faced by third-sector organisations in implementing CE innovations. Research by [101] underscores the importance of the direct costs associated with innovation, such as upfront investment costs, which may place a significant burden on the financial resources of third-sector entities. Again, limited budgets and reliance on donations and grants may hinder the ability of these organisations to allocate sufficient funds to cover the direct costs of CE initiatives. This is also in line with a study by [102], which suggests the direct innovation costs, including research and development expenses or those related to experimentation and new program development, are a crucial challenge in financing innovative projects in the third sector. In contrast, the public sector typically benefits from more stable and diversified funding sources.

Consistent with the importance of financial capabilities highlighted by [34], our findings suggest that public sector organisations may have greater financial capacity to absorb direct innovation costs associated with circular initiatives. This is also corroborated by the absorptive capacity theory, which suggests that public sector entities, with their established structures and professional staff, may possess higher absorptive capacity, enabling them to navigate the complexities of innovation more effectively [95]. The availability of public funds allows these organisations to invest in research, development, and implementation of CE projects without being as heavily constrained by immediate financial considerations. As the financial vulnerability and reliance on external funding sources could make it more challenging for third-sector entities to allocate the necessary resources for innovation, policymakers and funding bodies should consider this cost factor when designing support mechanisms for CE initiatives, ensuring that third-sector organisations receive the necessary support to drive sustainable innovation.

Similarly, results on the more constraining influence of the perceived economic risks in the third sector are due to the greater sensitivity of third-sector organisations to such risks. For example, a study by [103] indicates that organisations, often operating with limited financial resources, are more cautious and risk-averse due to concerns about the economic viability of innovative projects. Perceived economic risks, such as uncertainties about return on investment and financial sustainability, can discourage third-sector organisations from engaging in CE-oriented innovations. This corresponds to our qualitative result on the constraining factor pertaining to financial return considerations (see Table 1). Economic uncertainties associated with innovation projects [104], such as potential revenue fluctuations and the unpredictability of donor support, contribute to the perceived economic risks for these organisations. Conversely, public sector entities perceive lower economic risks associated with CE initiatives, and their ability to absorb and manage risks, given their greater financial stability, can mitigate concerns about economic uncertainties commonly faced by third sector organisations. Policymakers and donors should, therefore, consider this risk factor when supporting CE projects in the third sector, providing mechanisms to alleviate perceived economic risks and encouraging innovation in sustainable practices.

In addition, the cost of finance is a more significant constraint for public sector organisations and can be explained by the financial constraints, budgetary processes, and bureaucratic structures in the public sector that may limit the accessibility of cost-effective finance for circular initiatives. The finding is consistent with cost considerations discussed in [105,106] and suggests that cost of finance, including interest rates and borrowing expenses, can pose substantial constraints to public sector innovations. This is broadly in line with the cost perspective discussed in the qualitative result on cost reduction categories (P1, P4, P5, P6, P7, T5). Public sector organisations often need to navigate complex financial structures, and their reliance on budget allocations and government funding can paradoxically create hurdles in accessing cost-effective finance for CE-oriented innovations. Public sector organisations operating within government budgetary constraints may encounter difficulties in securing affordable finance for innovative projects. The cost of raising external capital, including interest payments on debt, can significantly impact the overall cost of

finance for circular initiatives. In contrast, the third sector organisations may have more flexibility in addressing the cost of finance constraints via fundraising through donations and grants and may face fewer constraints related to external financing costs. Policymakers and financial decision-makers in the public sector should hence consider these challenges when designing financial mechanisms to support CE projects, ensuring that affordable financing options are available to drive sustainable innovation in the public sector.

The greater influence of the lack of qualified personnel in the third sector organisations (see Table 3) may be attributed to their limited financial resources, which pose challenges in CE-oriented innovations. Research by [107,108] shows that the competition for skilled professionals in the labour market and the potential inability of third-sector entities to offer competitive salaries and benefits may result in a scarcity of qualified personnel. This shortage of qualified personnel with expertise in environmental sustainability and CE practices may hinder these organisations' ability to drive innovative projects. The lack of attractive career paths and professional development opportunities in the third sector may exacerbate the challenge of attracting and retaining qualified individuals. In contrast, the public sector may have certain advantages as it often has established structures for talent development and recruitment. The public sector's ability to offer competitive salaries, comprehensive benefits, and a stable work environment may contribute to a more robust pool of qualified personnel. Therefore, this points to the need for policymakers and leaders in the third sector to consider strategies to enhance talent attraction and retention, such as professional development programs and partnerships with educational institutions, to overcome this barrier and drive sustainable innovation.

Table 3. Knowledge factors: Degree of importance.

Knowledge Factors	Sector	High	Medium	Low	Factor Not Experienced	No Answer	Total
Lack of qualified personnel	Public	14 (14.60%)	28 (29.20%)	08 (08.30%)	24 (25.00%)	22 (22.90%)	96 (100.00%)
	Third	10 (17.50%)	17 (29.80%)	10 (17.50%)	05 (08.80%)	15 (26.30%)	57 (100.00%)
Lack of information on markets	Public	02 (02.10%)	26 (27.10%)	09 (09.40%)	34 (35.40%)	25 (26.00%)	96 (100.00%)
	Third	06 (10.50%)	15 (26.30%)	12 (21.10%)	08 (14.00%)	16 (28.10%)	57 (100.00%)
Lack of information on technology	Public	02 (02.10%)	31 (32.30%)	10 (10.40%)	30 (31.30%)	23 (24.00%)	96 (100.00%)
	Third	07 (12.30%)	15 (26.30%)	11 (19.30%)	08 (14.00%)	16 (28.10%)	57 (100.00%)

Another knowledge factor pertaining to lack of information on markets found to be a more pronounced constraint for the third sector organisations compared to the public sector is due to the resource limitations faced by the third sector that may hinder their ability to invest in market research, limiting their understanding of market dynamics. This is in line with [109,110], which suggests that non-profit organisations may face difficulties in accessing market information due to their unique characteristics. Third-sector organisations may lack the financial resources and market research capabilities that are more prevalent in the private and public sectors. The public sector, with its regulatory and policymaking roles, however, may have access to more extensive market information. Research by [111] suggests that government agencies often collaborate with private sector partners and research institutions, enhancing their ability to gather and utilise market data for CE initiatives. The public sector's role in overseeing various industries and activities provides it with a broader perspective on market trends and opportunities. Policymakers should, therefore, consider strategies to provide access to market information, fostering collaboration and partnerships that enhance the market intelligence necessary for effective CE initiatives within the third sector.

Resource constraints in third-sector organisations pose hurdles in accessing and assimilating information on emerging technologies [112]. Quantitative results on the lack of information on markets and technology are corroborated by the qualitative data analysis on knowledge insufficiency that highlights the pivotal role of the lack of information associated with technology and market environment as hindrances to CE-oriented innovations (P2, P4, P7, T2, T3, T4, T5). This is consistent with absorptive capacity theory, as the resource constraints and limited technological expertise within these organisations may hinder their capacity to access and assimilate crucial information on emerging technologies relevant to CE initiatives [5]. The non-profit entities may lack the internal capacities and information networks necessary to stay abreast of technological advancements. This lack of information on technology can hinder the effective planning and implementation of CE initiatives within the third sector.

On the other hand, the public sector, with its regulatory and governance roles, may have greater access to technological information. Research by [113] suggests that government agencies often collaborate with research institutions and industry experts to gather information on technological developments. The public sector's involvement in shaping policies and regulations related to CE practices may also contribute to a more comprehensive understanding of relevant technologies. Policymakers should thus recognise the need to bridge this information gap, including fostering partnerships with research institutions and technology experts to enhance the technological literacy necessary for effective CE initiatives within the third sector.

Regarding the results presented in Table 4 on the market factors, both the market dominance by established businesses and uncertain demand for innovative goods or services appear to be more substantial constraints to CE-oriented innovations in third-sector organisations compared to the public sector. The finding on the former is in line with research by [114], which suggests that third-sector organisations face challenges in competing with established businesses that dominate markets. Non-profit organisations tend to find it difficult to challenge the market power and influence of large corporations, hindering their ability to drive CE innovations. The dominance of established businesses can create barriers to market entry and limit the collaboration opportunities for third-sector entities, which may encounter challenges in influencing established businesses to adopt circular practices due to the hierarchical structures and profit-driven motives of these corporations. In contrast, the public sector, with its regulatory and policymaking roles, has more influence over established businesses. For example, ref. [115] suggests that government agencies can shape market dynamics using regulations and incentives. The public sector's ability to set standards and requirements for circular practices may mitigate the influence of market-dominant businesses and create a more level playing field for CE initiatives. The financial constraints and limited market power of third-sector entities may limit their ability to compete with large corporations, highlighting the need for policymakers to consider strategies to address this imbalance, including regulatory measures and incentives that encourage third-sector entities to embrace CE practices and create a more inclusive market environment.

Table 4. Market factors: degree of importance.

Market Factors	Sector	High	Medium	Low	Factor Not Experienced	No Answer	Total
Market dominance by established businesses	Public	04 (04.20%)	13 (13.50%)	10 (10.40%)	43 (44.80%)	26 (27.10%)	96 (100.00%)
	Third	05 (08.80%)	10 (17.50%)	09 (15.80%)	18 (31.60%)	15 (26.30%)	57 (100.00%)
Uncertain demand for innovative goods or services	Public	06 (06.30%)	17 (17.70%)	12 (12.50%)	35 (36.50%)	26 (27.10%)	96 (100.00%)
	Third	04 (07.00%)	11 (19.30%)	09 (15.80%)	17 (29.80%)	16 (28.10%)	57 (100.00%)

Uncertain demand for innovative goods or services in the third sector may be due to the challenges faced by these organisations in gauging and responding to market demand, as they may have limited market research capabilities. Given the resource constraints discussed, non-profit organisations may be more vulnerable to market changes for environmentally sustainable goods or services. This uncertainty may hinder the ability of third-sector organisations to anticipate and respond effectively to demand for CE initiatives [116,117]. Conversely, government agencies can influence demand via regulations and policy interventions and are thus more able to set standards and requirements for circular practices that may create a more predictable market environment for CE innovations. Therefore, policymakers should consider strategies to address this uncertainty, including providing resources for market research and creating policy frameworks that stimulate consistent demand for CE initiatives for the third sector. This suggests the need for policymakers to recognise the unique challenges faced by third-sector organisations and work collaboratively to provide stability to the demand for circular initiatives and encourage the adoption of CE-oriented innovations in the third sector.

As regards the other potential constraints, the results reported in Table 5 indicate that both UK and EU regulations, as well as Brexit, have more substantial constraining influences on public sector organisations. While both public and third-sector entities are subject to regulatory frameworks, the literature suggests that the public sector may face more significant challenges due to its size, bureaucracy, and the complexities of implementing innovative practices aligned with CE goals [118–120]. This is supported by the qualitative evidence on the essential role of bureaucracy and the requirement for leadership pertaining to the mindset change aspect (P2, P4, P5, T2). The bureaucratic nature of the public sector can lead to slower decision-making and implementation processes in response to changing regulations related to CE initiatives. The uncertainties introduced by Brexit can impact the institutional environment within which public sector organisations operate, potentially hindering their ability to adapt to CE-oriented innovations, while third sector organisations, often characterised by more flexibility and a flatter organisational structure, may find it easier to adapt to regulatory changes [121].

In agreement with the theory that provides insights into how transaction costs influence organisational behaviour, public sector organisations, being larger and more complex, may face higher transaction costs associated with compliance with new CE regulations. The administrative burdens, coordination challenges, and potential resistance to change within bureaucratic structures can contribute to elevated transaction costs [122]. Whilst third sector organisations, often funded using a mix of donations, grants, and fundraising, may have more flexibility in reallocating resources to align with regulatory requirements, public sector entities, subject to political considerations, may face challenges in reallocating resources to comply with new CE regulations. The need for budgetary approvals, bureaucratic procedures, and political negotiations can slow down the process of allocating resources for circular-oriented innovations. The public sector may thus face higher transaction costs associated with realigning policies, procedures, and relationships in response to Brexit. Hence, policymakers need to be cognizant of the specific challenges faced by the public sector in adapting to regulatory changes and consider strategies to streamline processes, reduce bureaucratic hurdles, and provide support to facilitate the effective implementation of CE initiatives in the public sector.

Table 5. Other factors: Degree of importance.

Other Factors	Sector	High	Medium	Low	Factor Not Experienced	No Answer	Total
UK Regulations	Public	14 (14.60%)	11 (11.50%)	08 (08.30%)	37 (38.50%)	26 (27.10%)	96 (100.00%)
	Third	06 (10.50%)	07 (12.30%)	07 (12.30%)	21 (36.80%)	16 (28.10%)	57 (100.00%)
EU Regulations	Public	08 (08.30%)	09 (09.40%)	11 (11.50%)	41 (42.70%)	27 (28.10%)	96 (100.00%)
	Third	02 (03.50%)	09 (15.80%)	07 (12.30%)	23 (40.40%)	16 (28.10%)	57 (100.00%)
Preparations to leave the EU (Brexit)	Public	10 (10.40%)	12 (12.50%)	05 (05.20%)	42 (43.80%)	27 (28.10%)	96 (100.00%)
	Third	00 (00.00%)	06 (10.50%)	18 (31.60%)	17 (29.80%)	16 (28.10%)	57 (100.00%)

To further examine the statistical significance of the differences between the public sector and third sector organisations, we also performed Mann–Whitney tests and the statistical significance was determined based on a 95% level of confidence (see Table 6).

The test results displayed in Table 6 indicate that the difference between the public sector and the third sector was statistically significant in the case of the constraints associated with the availability of finance (cost factor) and the lack of information on technology (knowledge factor). The comparison between the public sector and third-sector organisations, however, showed no statistically significant differences between the sectors in the case of other constraining factors. This, therefore, further substantiates the earlier findings that while the constraint arising from the availability of finance is of paramount importance in both the public sector and the third sector, there are indeed significant differences between the two sectors, and the third sector (38.6%) experienced this cost factor to a much greater extent than the public sector (29.20%). Similarly, the constraint associated with the lack of information on technology has a considerable influence on the innovation activities of the third sector (12.30%) compared to the public sector (2.10%).

Our finding regarding the higher importance of the availability of finance as a constraint to the innovation activities (or influencing a decision not to innovate) of third sector organisations might be due to the nature of third sector organisations, many of which tend to be non-profit or co-operative organisations, a structural setting that often restricts access to a broader range of financial capital (for instance, equity capital). Additionally, this finding could be attributed to the lack of fixed operating assets in third-sector organisations, which tend to limit their access to debt financing [123,124]. Another statistically significant finding regarding the higher degree of importance of the lack of information on technology as a constraint to third sector organisations' innovation activities is likely due to the lack of time and funding for such organisations to learn/acquire new, more efficient technology or make greater use of information pertaining to technology as they tend to be mostly small voluntary organisations with limited resources. This finding is in line with the results reported by the Institute for Voluntary Action Research and the Centre for Acceleration of Social Technology [125], which suggests that the technological constraint is particularly pronounced in small charities because of the lack of time to research and test different approaches and the lack of funding to invest in technology.

Based on the findings, a summary of the answer to the research question is provided in Table 7 below.

Table 6. Relative importance of cost factors, knowledge factors, market factors and other factors for public sector versus third sector.

Constraining Factors		Sector	Mean Rank	p Value
Cost factors				
	Availability of finance	Public	73.65	
		Third	82.65	0.029
	Direct innovation cost too high	Public	76.31	
		Third	78.16	0.798
	Excessive perceived economic risks	Public	75.33	
		Third	79.81	0.536
	Cost of finance	Public	77.58	
		Third	76.03	0.829
Knowledge factors				
	Lack of qualified personnel	Public	75.49	
		Third	79.54	0.574
	Lack of information on markets	Public	73.39	
		Third	83.09	0.176
	Lack of information on technology	Public	74.58	
		Third	81.08	0.035
Market factors				
	Market dominance by established businesses	Public	73.82	
		Third	82.35	0.228
	Uncertain demand for innovative goods or services	Public	76.14	
		Third	78.46	0.745
Other factors				
	UK Regulations	Public	77.57	
		Third	76.04	0.829
	EU Regulations	Public	76.77	
		Third	77.39	0.923
	Preparations to leave the EU (Brexit)	Public	76.34	
		Third	78.11	0.804

Table 7. How do the factors influencing innovation activities differ between the public sector and the third sector?

Constraining Factors	How Do the Factors Differ?
Cost factors	
Availability of finance	More constraining in the third sector than in the public sector counterpart *
Direct innovation cost too high	More constraining in the third sector than in the public sector counterpart
Excessive perceived economic risks	More constraining in the third sector than in the public sector counterpart
Cost of finance	More constraining in the public sector than in the third sector counterpart
Knowledge factors	
Lack of qualified personnel	More constraining in the third sector than in the public sector counterpart
Lack of information on markets	More constraining in the third sector than in the public sector counterpart
Lack of information on technology	More constraining in the third sector than in the public sector counterpart *
Market factors	
Market dominance by established businesses	More constraining in the third sector than in the public sector counterpart
Uncertain demand for innovative goods or services	More constraining in the third sector than in the public sector counterpart

Table 7. *Cont.*

Constraining Factors	How Do the Factors Differ?
Other factors	
UK Regulations	More constraining in the public sector than in the third sector counterpart
EU Regulations	More constraining in the public sector than in the third sector counterpart
Preparations to leave the EU (Brexit)	More constraining in the public sector than in the third sector counterpart

Note: The statistically significant constraining factors are denoted by an asterisk in column three.

4.3. Implications/Recommendations

The insights gained from the results are anticipated to further contribute to the theory and practice of public and third-sector CE-oriented innovations from the following perspectives.

Tailored and effective policies: Understanding the differences in the degree of importance of various constraints influencing CE-oriented innovation activities between public-sector organisations and third-sector counterparts is essential for crafting policies that are tailored to the unique needs, challenges, and capabilities of each sector. Policy interventions that consider these differences are more likely to be effective, as they can address specific barriers and opportunities [20,77,126]. This ensures that policies in each sector resonate with the realities on the ground and are more likely to drive the CE forward.

Resource allocation optimisation: Policymakers face the challenge of allocating limited resources to support CE initiatives. In light of the tremendous budget pressures in the U.K. and many countries around the world nowadays, research that delves into the differences in constraining factors to innovation activities can provide insights into resource allocation, allowing policymakers to optimise their investment [127]. This means that funding and support can be directed towards targeted activities that are likely to yield the most substantial benefits, ultimately maximising the impact of policy initiatives in each sector.

Evidence-based decision-making: Empirical evidence on how different constraints are important in influencing innovation activities in public sector versus third-sector organisations provides policymakers with an evidence-based foundation for decision-making. It allows them to make customised, informed choices regarding which policies to enact, modify, or discontinue in each sector. Such informed decision-making minimises the risk of unintended consequences and ensures that policies are grounded in empirical realities in each sector.

Stakeholder engagement: Successful CE policies often require the active participation of both public and third-sector organisations, along with other stakeholders. Understanding the unique motivations, constraints, and challenges of public versus third sectors enhances the engagement process (see, for instance, [128]). Policymakers can tailor their approaches in different sectors to foster stronger partnerships and collaborations from all relevant parties, ensuring a more customised, holistic, and integrated approach to CE initiatives.

Long-term sustainability: The transition to a CE is not a short-term project but a long-term societal transformation. Advancing understanding of how the factors influencing CE-oriented innovations differ between the public sector and the third sector organisations helps policymakers design more targeted policies that encourage the sustainability of circular practices over time in different sectors. It allows for the development of tailored policies that mitigate constraining factors and cultivate and support the integration of circular principles into the fabric of public versus third-sector activities for the long haul.

5. Conclusions

This paper addresses the question of how the factors influencing innovation activities differ between public-sector and third-sector organisations in a CE-oriented innovation context. We investigate the motivations of CE-oriented innovations and constraints for innovation activities in the public sector versus third-sector organisations. This distinction is cru-

cial and under-explored, as the third sector's role in CE innovation is growing, necessitating tailored policies instead of homogenous integration into public sector-based approaches.

The results suggest that the availability of finance, direct innovation cost, perceived economic risk, knowledge as well as market factors have more constraining influence on the third sector organisations, whereas the cost of finance and other factors, including regulatory factors, appear to be more influential constraints for the public sector entities.

The study is based on empirical evidence, which in turn fills in a gap in the current literature. Our paper has advanced knowledge of the key differences in constraints to innovation activities between public- and third-sector organisations in the context of the CE, which is crucial for effective policymaking. Practically, policymakers can rely on research findings to craft policies that are informed, effective and efficient. Such policies are more likely to succeed in driving the CE and can create lasting and sustainable change in each sector. By recognising the importance of these differences, policymakers can develop more focused policies that facilitate a more resilient and sustainable future.

Our research points to the statistically significant differences in cost factor constraints related to the availability of finance between the public sector and third sector organisations, with the third sector experiencing this constraint to their innovation activities to a much greater extent, likely due to the nature and structural setting of third sector organisations as they tend to be non-profit organisations with limited access to a broader range of financial capital. A policy recommendation naturally follows from this finding that points to the importance of policy initiatives or interventions to support/widen the access to funding tailored to the financial capital needs of third-sector organisations.

Furthermore, statistical evidence reveals significant disparities between the public and third sectors regarding knowledge gaps in technology, underscoring its heightened significance for third sector organizations. This finding might be attributable to the third-sector organisations' lack of resources, such as funding to invest in more efficient technology. This result also highlights the crucial role of policy initiatives or interventions to support the third sector organisations by, for example, subsidising experimentation and training costs pertaining to digitalisation in small third-sector organisations.

While this research advances existing knowledge, adds to both academic literature and policy implications, and opens avenues for future research, this study has some limitations. First, the qualitative research engaged twelve interviewees, who may not represent the whole public and third-sector organisations. Second, similarly, the questionnaire survey was only based in the South Wales region. Thirdly, this paper focuses on the constraints for CE-oriented innovation activities in the public sector and third-sector organisations and has not directly explored other factors, such as collaboration [59,129,130], which are also important to innovation. Additionally, the survey did not cover questions on what specific constraining factors impede the successful adoption and implementation of open innovations and how the dynamics of open innovation differ between the public sector and third-sector organisations in these distinct contexts.

The above limitations also provided avenues for future research. First, more empirical studies, especially interviews and case studies [131,132], should be conducted to explore more detailed processes and activation mechanisms for CE-oriented innovation projects. Questions such as 'what are the learning process?' 'How to collaborate with partners during the innovation process' can be considered for future interviews. Such empirical studies can be applied to both third- and public-sector CE-oriented innovation projects. Second, based on case studies, there could be further comparative research to address differences in terms of CE-oriented innovation process [133], prioritised areas and performance indicators [134,135]. Thirdly, another further research area could be to examine how the constraints for CE-oriented innovations are linked to the investment and training for innovation activities versus those for specific product innovations in different sectors. Fourthly, it would also be interesting to investigate CE-oriented innovations in the light of open innovation [130,136,137] and innovation strategies [94,138] at various stages of the innovation life cycle [139,140].

Author Contributions: Conceptualisation, K.S.K.; methodology, G.W., Z.L. and K.S.K.; formal analysis, K.S.K. and Z.L.; data collection, Z.L. and G.W.; writing—original draft preparation, K.S.K. and Z.L.; writing—review and editing, N.C., K.S.K., Z.L. and G.W. All authors have read and agreed to the published version of the manuscript.

Funding: The Circular Economy Innovation Communities project used for this research was funded by the European Social Fund under grant WWV 82251.

Institutional Review Board Statement: This research has been approved by the School of Management Research Ethics Committee (Swansea University) and the Cardiff School of Management Research Ethics Committee (Cardiff Metropolitan University).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are available from the authors upon request.

Acknowledgments: The authors would like to thank the Editorial Team and four anonymous expert reviewers for constructive comments and suggestions. We would also like to acknowledge the Circular Economy Innovation Communities (CEIC) Programme for the data access and opportunities to disseminate the findings of this paper, and thank all participants for the questionnaire survey and Karen Young for her help in transcribing the interview data.

Conflicts of Interest: The authors declare there are no potential conflicts of interest with respect to this article's research, authorship and/or publication.

Appendix A

Sample Survey Questionnaire

Part 1

1.1 Cost factors: Availability of finance—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

1.2 Cost factors: Direct innovation cost too high—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

1.3 Cost factors: Excessive perceived economic risks—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

1.4 Cost factors: Cost of finance—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

Part 2

2.1 Knowledge factors: Lack of qualified personnel—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

2.2 Knowledge factors: Lack of innovation on markets—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

2.3 Knowledge factors: Lack of innovation on technology—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

Part 3

3.1 Market factors: Market dominance by established businesses—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

3.2 Market factors: Uncertain demand for innovative goods/services—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

Part 4

4.1 Other factors: UK regulations—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

4.2 Other factors: EU regulations—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

4.3 Other factors: Preparations to leave the EU (Brexit)—Degree of importance?

- High
- Medium
- Low
- Factor not experienced
- No answer

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