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Developing a model of circular economy engagement for public sector organizations

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IMPACT

Humans face an existential crisis if we fail to transition to a circular economy (CE) and reduce fossil fuel consumption. Public service organizations (PSOs) are major employers and owners of significant physical estates and procure hundreds of billions in products and services annually. The UK government aims to achieve 'net zero' environmental targets by 2030 but has left PSOs to operationalize strategy without clear methodologies and with ambiguous terms. This article explores and articulates public service practitioners' understanding of CE principles and their approaches to implementation, to develop a model that enhances practitioners' understanding of CE and enables practitioners to more fully understand how to approach implementation of circular economy principles. This article presents evidence from practitioners from multiple PSOs, located in Wales, who are engaged with contextualizing CE and implementing CE principles at an organizational level.

ABSTRACT

Public service organizations (PSOs) are well placed to leverage the opportunities a circular economy (CE) transition presents and are obliged to deliver social value. Recent academic literature suggests that the term 'circular economy' is a contested concept, suggesting that context (among other variables) is important. This article draws on a contemporary definition, developed from an analysis of 221 definitions, to frame understanding for public service practitioners and comment on their contextualization of the term. Contemporary research suggests that adoption of CE principles within UK PSOs is minimal, due to limited understanding of CE, together with PSOs' underdeveloped innovation capabilities. This article draws on nascent research that has explored PSOs' perspectives on CE and published frameworks for the implementation of CE principles. The objectives of the article are to identify, discuss and develop the understanding of CE and its implementation within PSOs and to present a framework that builds on existing research and provides practitioners with a model that better develops their understanding of how to approach CE innovation.

KEYWORDS

Circular economy; FsQCA; innovation, innovation capabilities; public sector; public service organizations; regional innovation; sustainability

Introduction

The public sector is the biggest of all the service industries in terms of employment levels and physical assets, employing 18% of the UK workforce, 32% of workers in Wales (StatsWales, 2024), and 25% of the total EU workforce (Klein et al., 2022). Public sector organizations (PSOs) employ significant numbers of staff and, while serving local and national stakeholders, have a significant role in implementing 'circular economy' (CE) principles that goes beyond policy implementation and creating public value (Torfing, 2019). Yet practical progress of public sector engagement with the CE is limited (Clifton et al., 2024; De Laurentis, et al., 2024; Klein et al., 2022) and the study of CE in PSOs remains immature (Droege et al., 2021).

The CE represents:

... a regenerative economic system which necessitates a paradigm shift to replace the 'end of life' concept with reducing, alternatively reusing, recycling, and recovering materials throughout the supply chain, with the aim to promote value maintenance and sustainable development, creating environmental quality, economic development, and social equity, to the benefit of current and future generations.

It is enabled by an alliance of stakeholders (industry, consumers, policy makers, academia) and their technological innovations and capabilities (Kirchherr et al., 2023, p. 4).

Academic definitions of CE are contested (Korhonen et al., 2018), despite agreement that CE is critical for reducing costs, waste and environmental impact (Kirchherr et al., 2023). This ambiguity, and a paucity of benchmark organizations, has not helped promote its relevance and deployment by PSOs.

The CE approach creates a 'closed loop' of usage/consumption (and re-entry into use) in the form of a regenerated product that was once new (created and 'cradled') to a new 'cradled life', reducing waste by curtailing consumption and creating almost infinite reuse (and reduced costs and resource depletion of the linear mode of production), to provide economic value in every subsequent re-cradling (Kirchherr et al., 2023; Stahel, 2016). To build a CE, a transformation of PSO operating models is needed to embrace three critical CE principles:

- The elimination of waste/pollution.
- Circulation of products and materials.
- The regeneration of nature (natural resource augmentation).

Consumption of resources has grown exponentially as demand from population growth and 'system shocks', such as the Covid 19 pandemic, have disrupted global supply chains (Welsh Government, 2021). With each shock, the urgency to re-think operating models and shift to increased sustainability afforded by embracing CE principles has intensified (European Commission, 2024). The European Commission's Green Deal Industrial Plan (2024) set targets for waste recycling to promote a more circular and resource-efficient economy. In Wales, the context of this study, the Welsh Government stated it would 'use the powers and levers that we have ... to accelerate our transition to a circular, low carbon economy' (Welsh Government, 2021, p. 4). This CE strategy set targets for local authorities to recycle 70% of domestic waste and established eight key policy-driven priorities. Implementation of established international management standards in procurement contracts has also increased demands on organizations, especially PSO suppliers, to design and implement methods to enhance environmental sustainability and circularity, and lower negative environmental impacts (see ISO standards ISO 14001 and BS 8001). The increasing adoption of Environmental, Social & Governance (ESG) corporate reporting signals a holistic approach and emphasises systematic rethinking of the longer-term environmental viability of the organization, its suppliers and its local stakeholder/communities to demonstrate sustainable improvements that support environmentally responsible management.

Environmental stewardship (Stahel, 2016) is not a new concept for businesses or PSOs, yet meaningful progress in this area of critical management practice is limited. The public sector does not often recognize the finite nature of the materials it uses, and few organizations exist to emulate and 'model' better behaviour. Existing studies of PSOs indicate that further theory is needed to inform practice (Clifton et al., 2024; Kirchherr et al., 2023). UK government advocacy of a circular approach is promoted by its policies, material bodies and trade sector goals—such as the Extended Producer Responsibility legislation (Department for Environment, Food & Rural Affairs, 2022). Klein et al. (2022) assessed PSO employee perceptions and concluded there was a requirement to analyse national, regional and organizational level initiatives to determine levels of CE implementation within the public sector. Barreiro-Gen and Lozano (2020) called for insights into organizational-level CE practices and Droege et al. (2021) lamented the dearth of frameworks to assess CE implementation with PSOs.

To remedy these extant research gaps, this article first explores the internal processes and operations that facilitate the implementation of CE principles within PSOs. Second, it provides empirical insight into the internal innovation processes within PSOs, requested by De Laurentis et al. (2024) and Clifton, et al. (2024). Finally, this study extends the work of Droege et al. (2021), Klein et al. (2022), Liu et al. (2022) and De Laurentis et al. (2024) who have presented frameworks that contribute to an understanding of circularity from a public sector perspective, within the region of Wales.

Literature review

A literature review was conducted to frame the current research and body of knowledge concerning the CE and

PSOs. Online repositories, including EBSCO, Scopus, Google Scholar and Proquest, were interrogated for relevant contributions to the CE, sustainability, and environmental management of the public sector. An integrative review by Klein et al. (2022) found that the PSO literature focused on three areas. First, the study of CE practices in public procurement; second, the exploration of CE practices within internal operations, procedures and practices; and, third, on how CE has been applied to the services PSOs deliver to citizens and society. This article focuses on antecedents and necessary elements for managers to implement CE within internal operations and processes, as perceived by managers of PSOs. The literature review revealed seven key CE antecedents and elements. These elements, forming the main dimensions of PSO management practices, will now be explored from a regional context perspective.

Directional strategy and structures

PSOs must contend with institutional pressures, satisfy stakeholders' demands, deliver government policies and statutory obligations, conform to required audit requirements (predominantly within public procurement and their built environment estate) and innovate where practical. (Walpole et al., 2022). These pressures set public services apart from private sector enterprises and third sector organizations. PSOs in Wales are subject to UK government statutory obligations and regional Welsh Government obligations and strategies (De Laurentis et al., 2024).

The Welsh government has embraced the concept of CE and integrated it within statutory obligations for all PSOs in Wales (De Laurentis et al., 2024). The Wellbeing of Future Generations Act (Welsh Government, 2015) added further statutory obligations on public bodies, within a wider strategic framework, to embed 'Seven Well-being Goals'. The act obliges PSOs to embed sustainable development goals into governance and policy-making and promotes a holistic interconnected approach to factors affecting population well-being. The publication of the Beyond Recycling strategy (Welsh Government, 2021) explicitly described the need to build on the success of recycling policies and transition to a 'low carbon, circular economy' in Wales, through a collaborative ecosystems approach which closely aligns with the EU Green Deal (2024) policies (De Laurentis et al., 2024).

The resultant strategic focus of PSOs in Wales has moved from a concern to reduce, reuse and recycle (the '3R's) to the 9R model of refuse, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover energy (Kirchherr et al., 2023). Contemporary frameworks enable a holistic approach and demand systems thinking with multiple sources of feedback that are often missing within linear economy systems (Kirchherr et al., 2023). The use of frameworks such as the 9Rs does, however, add ambiguity for PSO leaders seeking to convert statutory obligations into operational targets and develop processes to transition to a new circular future state (Clifton, et al., 2024).

The transition to a CE model requires appropriate organizational policies, practices and structures implemented across all functional areas of PSO service provision. It is also necessary to engage with the professional 'best practice' management standards and

conform with macro-level policies and obligations (De Laurentis et al., 2024). PSOs highlight the use of environmental impact assessments and carbon reduction plans for specific projects undertaken with a limited range of suppliers and new regulations, such as PPN06/21 (Department for Environment, Food & Rural Affairs, 2022), within public procurement. However, a dearth of evidence exists that evidences the systematic approach required to underpin progress to transition to a CE operating model.

Regulation and conformance to standards

The International Standards Organization (ISO) and its national standards body network has adapted its management standards to include a greater ecosystems approach. The British Standard BS 8001 (BSI, 2015), a framework standard, was developed for implementation of CE principles and yet a dearth of empirical evidence exists for its use and effectiveness by PSOs (Klein et al., 2022). ISO 14001, a third party audited environmental management standard (EMS), is widely adopted and sets out the areas of management practices needed to conform to this ‘best practice’ (Rich & Malik, 2019). ISO 14001 and other standards (such as the Eco-Management and Audit Scheme) demand specific practices, including the conduct of a product/service life-cycle assessment, assessment of business operations and their environmental impact and procedures for emergency preparedness to react to environmental catastrophes. Such standards dominate manufactured product supply chain accreditation and qualification of trading supply chain partners (Rich & Malik, 2019). These standards are used by PSO purchasing—especially those relevant to the UN Sustainable Development Goals. The implementation and utility of EMS/sustainability processes are practical and provide measurable progress against environmental targets and/or departmental targets (Klein et al., 2022). However, implementing and conforming to EMS seldom equates to organization-wide adoption of CE principles as EMS conformance is typically restricted to estates departments

(Dagilienė et al., 2021). EMS emphasise auditable (annual independent third-party audits) and documented management processes and practices (Rich & Malik, 2019). The value of ISO or EMAS accreditation includes innovation and continuous improvement capabilities, audited discrepancies from the standard must be corrected by amendment of each non-conforming process. Areas of conformance include seven key clauses (processes), the first auditable clause concerns the ‘context of the organization’ (Table 1), which explicitly links the objectives and obligations of an organization with their improvement processes and practices.

ISO 14001 strongly supports circularity: serving as a framework to operationalize policy statements and a positive relationship between conformance to an environmental standard and achievement of circular processes and improved service provision (Klein et al., 2022). Our literature review also described the implementation of standards as a ‘baseline’ and useful practices for circularity (Ayati et al., 2022). All ISO management standards have recently emphasised a systems approach to managing environmental management and thus implicitly support circularity (Liu et al., 2024). In parallel, regulators with legal and punitive powers have increased scrutiny and demanded greater levels of transparency when auditing and thus accelerated the implementation of ISO standards as proof of ‘good practice’ (Klein et al., 2022).

Economics of CE

Any societal shift requires high investment and reallocation of value and studies indicate that adopting a cradle-to-cradle operating model of circularity is constrained by the economic viability of the circular approach, with high ‘upfront’ investment costs frequently cited as a barrier to CE implementation (Grafström & Aasma, 2021). However, studies have demonstrated greater revenues, new contracts and increased profit result for private sector organizations that invest in CE implementation (Liu et al., 2024). Operational viability and derived user value is more likely to determine investments for public services (Klein et al., 2022). While PSOs are key actors in the economic system, due to their high ‘influencing power’, studies suggest that PSOs are reluctant to engage with CE interventions when costs exceed financial benefits (De Laurentis et al., 2024; Corvellec et al., 2022). Authors suggest ‘upfront costs’ and ‘opportunity costs’ are a barrier to circular initiatives and yet CE implementation can create more economic and environmental value because products are built to last, retaining much more of a product’s embedded materials, energy and labour (Ayati et al., 2022).

Supply chain

Welsh Government (2021) data suggests that 81% of NHS Wales’ carbon footprint is due to its ‘scope 3’ emissions, which are purchased goods and services. Public procurement contracts (capital equipment and consumable items) account for 18% of the EU’s total GDP (European Commission, 2024) and therefore public procurement offers a significant lever to support the transitions to CE through public procurement practices (Dagilienė et al., 2021).

Table 1. The clauses of ISO 14001.

General clauses	System features documented for ISO 14001: ready for internal/external auditing
4. Context of the organization	Understanding the organization in its ecosystem, interested parties and their expectations, and determining the management system to address environmental concerns/practice (ISO 14001).
5. Leadership	Leadership, commitment, roles, responsibilities, and authorities of all staff.
6. Planning	Actions to address risks and opportunities, objective setting and plans to achieve goals.
7. Support	Processes to assign and test resources for the EMS, staff competence, awareness, communication, documented processes and controlling documents.
8. Operation	Planning and control of the Environmental Management System (EMS) in practice.
9. Performance evaluation	Internal auditing, measurement, evaluations, and senior management reviews of the EMS’s performance to inform plans and corrective actions.
10. Improvement	Processes to manage non-conformance to the ISO standard, ensuring reactive corrective actions are undertaken and are effective to stimulate continual improvement of the organization and its processes.

However, an emphasis on 'value for money' in public procurement often results in the cheapest 'bid', that meets the technical criteria, being selected despite supplier sustainability credentials. Performance improvement interventions, sustainable supply chains and 'industry 4.0' models offer potential value to support the transition to a CE for PSOs (Ayati et al., 2022; Liu et al., 2024). Fulconis et al. (2018) argued applying the concept of frugal production chains in the CE context increased resource efficiency. Mishra et al. (2018) demonstrated how value creation, by applying re-use and recycling product strategies, resulted in greater value.

Recent UK government legislation (PPN06/21, 2021) requires all contractors to have a carbon reduction plan if applying for contracts above £5 million and PSOs in Wales must apply WFGA (Welsh Government, 2015) and social value considerations in purchasing contracts (Welsh Government, 2023). This legislation is supporting under-resourced public procurement professionals in Wales to implement CE principles, albeit too slowly (De Laurentis et al., 2024). The longer term PSO-supplier relationships can support mutual benefits of CE innovations throughout the supply chain. Hence, to become more environmentally sustainable PSOs must focus upon reducing waste, reducing energy consumption (and using green energy) and encouraging their supply chain to transition from linear a CE paradigm, which will require considerable supply chain redesign (Klein et al., 2022). Therefore, the PSOs' role in the supply chain could play a key role to influence adoption of CE principles across regions and sectors (Burke et al., 2023).

However, the PSO supply chain is characterised by large, often oligopolistic, providers due to the size of PSO contracts and the 'value' PSOs place on price, driven by economies of scale. Conversely, CE principles require support from local suppliers (to repair, refurbish and recycle) or distributed manufacturing where large-scale manufacturing sites are displaced by smaller local sites (Burke et al., 2023). Unfortunately, the recent trend to 'buy local' remains poorly explored, rare or case-specific accounts exist (Burke et al., 2023). Regardless of sector, information, knowledge, and skills deficiencies pose significant barriers to supply chain management (Ayati et al., 2022). Therefore, relationships with local circular businesses for the recirculation of assets, that were once made by OEMs (first build) suppliers, might need to be created. Furthermore, leased product arrangements can be hindered by contractual clauses that might prevent local 're-cradling' (Ayati et al., 2022).

Innovation and knowledge transfer

CE practices require considerable organizational innovation and change, the forming of inter-organizational partnerships and taking a multi-level approach to incorporate all actors and stakeholders (Klein et al., 2022; Clifton, et al., 2024). The CE paradigm demands a 'systems approach' requiring PSOs to work with stakeholders to implement CE principles (Kirchherr et al., 2023; Clifton, Kyaw, et al., 2024). The formation of a 'CE ecosystem' enables knowledge transfer processes to optimise service solutions with other sector and regional stakeholders, including local universities (Liu et al., 2022). CE ecosystems require knowledge transfer, risk-sharing and innovation

capabilities (Clifton, et al., 2024; Walpole et al., 2022). Clifton, et al. (2024) argue such ecosystems can stimulate innovation and support the development of inter-organizational new service solution development and organizational innovation readiness (Ojiako et al., 2022) that ensure service delivery meets national targets (Clifton, et al., 2024). Contemporary research suggests the triple helix approach offers a mechanism to create an effective regional CE ecosystem (Walpole et al., 2022). The triple helix model implies that each helix (university, industry and local/national government) are actors that can create a dynamic regional innovation ecosystem (Liu et al., 2022), where actors collaborate to drive innovation adoption of social value using CE principles (Clifton, Kyaw, et al., 2024).

While PSOs may regularly audit their internal processes, engaging with new forms of knowledge is key in realizing the shift to CE (Klein et al., 2022). Thus, PSOs should increase opportunities to engage in knowledge transfer, by attending external events to learn more about environmental performance and participate in innovation programmes (Clifton, Kyaw, et al., 2024). Through development of innovation capabilities (Walpole et al., 2022) and enhancement of knowledge transfer capabilities (Liu et al., 2024), PSOs can develop CE implementation processes and practices (Klein et al., 2022; Clifton, Kyaw, et al., 2024). Clifton, De Laurentis, et al. (2024) suggest that an integrated CE ecosystem of key stakeholders can support the implementation of CE into organizational management practices. Ecosystems enable knowledge, raw materials, technology, and information to be shared, allowing PSOs to establish the conditions needed to capture and develop CE related opportunities and innovations (Clifton, De Laurentis, et al., 2024; Liu et al., 2022).

Knowledge management and learning

Innovation and knowledge transfer capabilities are necessary within PSOs to enable innovation and continuous improvement (Liu et al., 2024). Walpole et al. (2022) reinforce the importance of these knowledge capability processes when setting strategic-level objectives and transforming from a linear to a circular approach. Omotayo (2015) proposes four critical elements of success:

- Knowledge (to manage).
- People (as sources of knowledge).
- Processes (that is how organizations govern, define, and implement these processes).
- Technology.

However, Omotayo (2015) does not elaborate on a temporal sequence for mastery or how best to combine these activities.

Research suggests there is a paucity of CE knowledge, and transformational innovations, within PSOs and local incremental improvement and reactive problem-solving remains the default mode of learning (Klein et al., 2022; Clifton, De Laurentis, et al., 2024). Staff -driven 'eco-innovation performance' seems absent in large staff-centric service organizations and investing in CE principles implementation is often focused on points in the service delivery process (Hislop et al., 2018). Given Rashman et al. (2009) assert that knowledge must be 'embedded' in the

intellectual competence of staff and the organizational culture to be effective, then progress for PSOs in supporting staff to apply their CE knowledge could be advanced through participation in innovation programmes and interventions (Walpole et al., 2024). Studies show employee awareness of CE is slowly increasing and PSOs are encouraging learning in this area (Klein et al., 2022). However, Clifton, De Laurentis, et al. (2024) suggest a paucity of implementation projects exists and propose organizational responsibility for CE implementation should be driven by organizational leaders to engage all employees and stakeholders (from service design, automation, delivery, and improvement).

Isomorphic change and emulation

Institutional theory, based on isomorphic pressure for change, identifies coercive sources, professional best practices or emulation of exemplar PSO organizations will accelerate adaptation rates (Clifton, et al., 2024). Many recent management models have gained sector dominance from emulating a perceived-successful model. However, there are few such cases for CE implementation emulation and mimetic isomorphism is not present in the PSO sector to emulate practices and behaviours (Droege et al., 2021). Drivers for isomorphic change within the public sector are fragmented, denoting the need for best practice sharing (Walpole et al., 2022) to increase the likelihood of emulation, in turn leading to PSO implementation of CE principles. Klein et al. (2022) emphasise the importance of PSOs adopting CE principles across their entire organizational strategy, processes and practices to serve as an example of good practice due to their role-model status and influence on their supply chain. Yet without emulating such change within the public sector by learning from best practice, PSOs are under-equipped to stimulate such innovation and change within wider sectors (Ojiako et al., 2022).

Summary of literature

The literature review presents a mixed view of progress for PSOs in applying CE principles and practices and a dominant approach of ad-hoc, incremental adjustments rather than transformational changes to operating models (a preference to reduce energy consumption, increasing recycling and re-use rates and increasing resource efficiency—see Kirchherr et al., 2023). The organizational-level implementation of CE within organization processes and practices, the focus of this study, are in their infancy and there is ‘significant potential to engage in stakeholder involvement methodologies to accelerate the transition to a CE’ (Klein et al., 2022, p. 774). To address this, and to frame discussions with practising professionals, the formulation of a conceptual model was required to ‘make sense’ of the critical dimensions that had been identified by previous researchers if utility were to be extracted by public sector practitioners. The intention of the conceptual model was to frame, as a systems approach, the critical issues that need to be addressed when implementing CE principles within the ‘internal processes and operations’ of PSOs (Klein et al., 2022).

The conceptual model

The methodology of this study draws from a critical realist epistemology, where the rigorous study of the subject was blended with an intention to inform management practice. The subject of PSO circularity is immature and devoid of validated and calibrated instruments for such a context (Klein et al., 2022). A context-rich account of perceptions and practice necessitated a theory building approach. The conceptual model, drawn from the extant literature, was empirically tested using a panel group interview of purposively selected experts, from across different PSOs within a region of the UK (Wales). The purposive selection of experts ensured that individuals held authority for system changes; possessed considerable expertise, including environmental management improvements, specialist management consulting and expert academics.

Deriving the conceptual model.

The first phase of the research collated the ‘current state’ of extant subject knowledge. Informants were purposively formed into panel groups to discuss the subject and, at the end of the discussion, reviewed the conceptual model which was presented to them as a graphic. The review represented a quality check of its validity.

The resultant conceptual model reflects the seven key themes detected in the literature review which form items that would need to be evident in any PSO CE implementation model. These areas of investigation were then expanded with the artefacts and practices that would logically be displayed by PSOs should they implement any of the seven characteristic features. The holistic model that was subsequently drawn using three concentric layers was used to frame the content and guide the discussions (methodological process). Each layer of the model was presented to the group, and participants were encouraged to share their thoughts on the internal correlations and dependencies of the elements within each ring of the model. It was evident from the discussion that sometimes a component within a ring/layer could be placed under a different theme highlighting the fact that each layer does have fluidity within it. For example, ‘dedicated staff’ could well be placed under several of the themes, but it was placed where it was deemed to have the strongest connection (i.e. strategy and structures). However, two different focus groups (independent of each other) mentioned that ‘stakeholder engagement’ should be added into the model to encompass sharing of values (i.e. value chains and value systems). Thus, the model was updated to include stakeholder engagement in the outer ring and has been linked to the supply chain theme.

The model at this stage was deemed to have gone through a robust quality assurance validation, using an established social scientific method (Leonard-Barton, 1990) and the conceptual model was revised based on this feedback.

Revised conceptual model

Figure 1 presents the revised conceptual model. The literature review highlighted several significant factors which increase engagement with CE and environmental sustainability. Nonetheless, consensus regarding how the CE should be

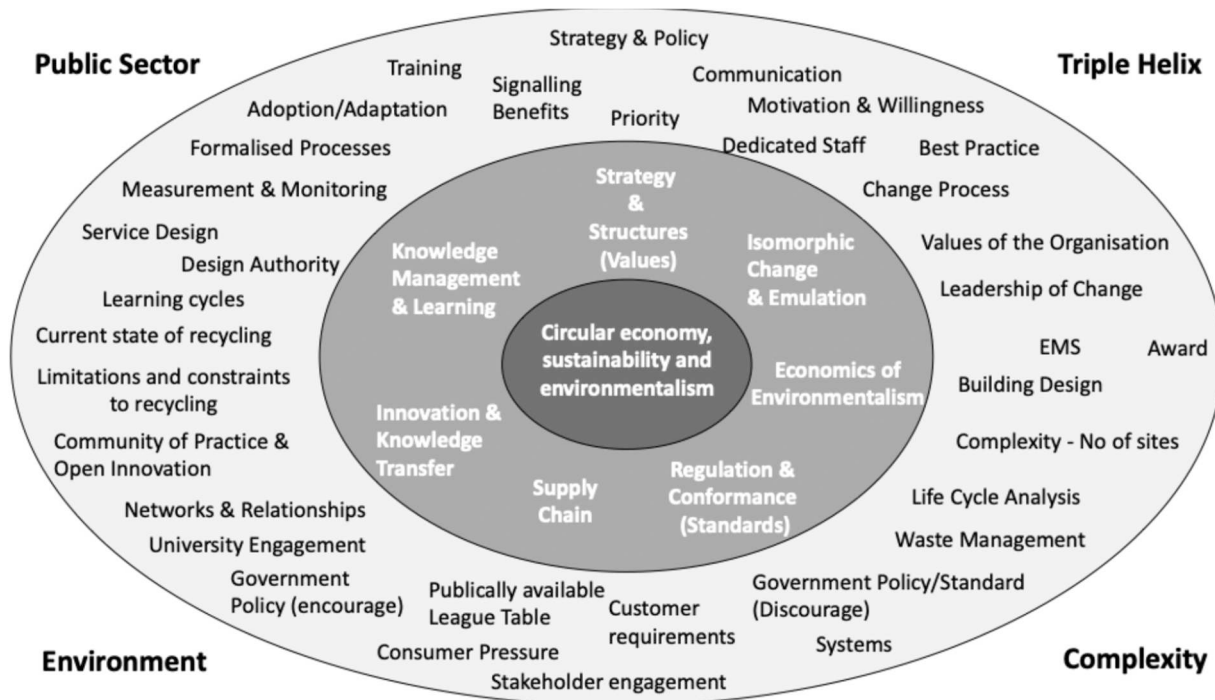


Figure 1. Holistic model.

implemented by PSOs is lacking (Clifton, De Laurentis, et al., 2024; Klein et al., 2022). This inconsistency within existing discourse inevitably makes it difficult for PSOs to understand the conditions necessary to enact this process. The nascent body of published subject literature indicates that the transition to a CE is complex and influenced by multiple interrelated causal conditions. This scenario is best tested using the analytical technique of fsQCA (Pappas & Woodside, 2021). While traditionally suited for qualitative analyses, fsQCA is a suitable technique for examining multiple case studies within a single study, and for analysing an outcome with multiple underlying pathways. It is therefore highly likely that PSO environmental sustainability involves multiple themes and processes, which could combine and manifest in multiple ways.

Another tenet of fsQCA is causal asymmetry, where conditions leading to the presence of the outcome differ from those leading to its absence (Fiss, 2011). Pappas and Woodside (2021) advised no single factor is likely to be sufficient or necessary when examining the complex phenomenon of success, and research that focuses solely on examining the presence of success is unlikely to shed light on the causes of failure. The literature underlying the conceptual framework for this study indicates that the presence of the conditions consistently associates with success and not failure, akin to Walpole et al. (2024) research. As fsQCA offers an asymmetric understanding of causality it possesses suitability for examining the expectedly asymmetrical outcome of success (Fiss, 2011). Therefore, while there may be many configurations leading to successful CE implementation, these may not be causally symmetrical when examining its absence (failure).

Methods

Data collection

Given that CE transition relies on multiple stakeholders, across regions and sectors (Clifton, et al., 2024) this study engaged

PSO managers from across a region from different PSOs. The researchers aimed to develop a model that would support practitioners to implement CE principles within their processes and practices and provide researchers with insights into how practitioners characterise implementation of CE principles. A questionnaire was created, containing statements corresponding to each element of the conceptual model. The model was tested and subsequently validated using focus group discussions with eight academic and industry experts with a mix of backgrounds in CE, sustainability, strategy, environmental management, project and change management along with both private and public sector knowledge. The inclusion criteria for selecting focus group participants were at least five years' experience, in PSOs, to possess the required knowledge to meaningfully discuss the key components of the model.

The purpose of the focus groups was to test the middle and outer ring of the model which captures the key thinking from the literature that was found to be relevant to both the private and public sector organizations implementing (or considering) CE initiatives. The first question posed was: 'What are the key, broad aspects of a CE?' This question aimed to test whether the seven key themes were present in the middle layer. After the groups had shared their thoughts on this, the seven key themes discovered in the literature review, were shared along with a summary of each (for clarification and understanding). The groups were then asked if they felt this covered all the points they had mentioned. Each group felt it did, thus validating this layer of the model.

The outer layer of the model was then tested by taking each theme, one at a time, and tasking the groups to share anything they felt was relevant to this theme in relation to the CE in general and the implementation of CE principles in the workplace. These discussions allowed the experts to give context-rich explanations, based on their personal experience in the field. After the discussion on all seven themes, the outer layer of the model was revealed and

discussed in detail to see if the groups felt that all their views had been incorporated. This phase enabled the researchers to assess the internal correlations and dependencies on the elements within the outer ring of the model and their connections to one (or more) of the seven inner ring themes. It was evident that some of the group's points had been placed under a different, theme highlighting the fact that the outer layer does have fluidity within it and yet it was felt that the strongest linkage with each relevant theme had enabled correct positioning. However, two different focus groups suggested that 'stakeholder management' should be added into the model that encompasses sharing of values (i.e. value chains and value systems). Thus, the model was updated to include this in the outer ring of the model and linked to the supply chain theme. The model, at this stage, was deemed to have been taken through a robust quality assurance validation process which enabled the next phase to be undertaken. The next phase involved gathering questionnaire data, discussed in the next section.

A seven-point Likert scale (strongly disagree to strongly agree) was used to ascertain each participant's level of agreement with each statement. Each construct contained a range of different statements. Fifty participants completed the questionnaire; and, due to missing data, a final sample of 34 usable responses was analysed. Welsh public sector practitioners headquartered within South Wales with an interest in the CE and reducing their environmental impact were invited to participate in the study. Participants included senior and middle managers, department heads from a range of PSOs, including the health, education and local government and transport. Participants were purposively selected based upon their enrolment in a WEFO funded project designed to encourage public and third sector practitioners to implement CE principles and develop innovation skills.

Analytical technique

The fsQCA technique enables the identification of patterns of elements that lead to a given outcome (Pappas & Woodside,

2021). This research necessitated a holistic analysis to examine each organization in depth, create cross-case comparisons of the variances between public sector practitioner perceptions of CE conditions and to identify factor combinations. FsQCA combines in-depth case familiarity (holistic qualitative analysis of complex organizations), with cross-case comparisons typically fostered by quantitative research to identify which specific causal conditions interact to produce a given outcome (Pappas & Woodside, 2021).

Qualitative case-oriented research is criticised for failing to incorporate formality and rigour into comparisons and for placing an emphasis on specific, individual cases (Fiss, 2011). On the other hand, quantitative (variable-oriented) research can over-emphasise variables and fail to capture detailed analyses of cases, overlooking their specificities in favour of examining variations across cases (Pappas & Woodside, 2021). FsQCA integrates both qualitative and quantitative analysis, allowing it to recognize the diversity and heterogeneity of cases and their causally relevant conditions and contexts through enabling cases to be compared as configurations (Fiss, 2011).

Calibration

FsQCA operates based on cases demonstrating degrees of membership within a set; to indicate set membership, data requires calibration into values between 0 and 1. The calibration procedure requires specification regarding threshold values as boundaries for full membership within the outcome, full non-membership, and the maximum level of ambiguity (Fiss, 2011). Data within this study was calibrated using the indirect method, with the value for full membership being fixed at 6; the crossover point set at 4; and full non-membership fixed at 2. Calibrating questionnaire data in this manner is an established approach within fsQCA (Pappas & Woodside, 2021). Following the calibration procedure, truth table analysis to refine two measures—frequency and consistency—is undertaken. Frequency concerns the number of empirical case observations containing each combination of conditions within a small data set. An acceptable frequency cut off can be set at 1 which according to Fiss (2011) assesses the degree to which the causal combinations represent a subset of the outcome; the minimum acceptable consistency threshold for any solution is often recommended as being 0.75. Based upon this guidance, cases with a frequency value of less than 1 and consistency values of less than 0.76 were removed from the truth table.

Results

Table 2 displays five different solutions for successful environmental sustainability and implementation of CE.

- Solution 1 combines the presence of knowledge management and learning, innovation and knowledge transfer, strategy and structures, and isomorphic change and emulation, with the absence of economics of environmentalism, and the redundancy of supply chain and regulation and conformance. Core conditions are the presence of knowledge management and learning.
- Solution 2 combines the presence of knowledge management and learning, innovation and knowledge

Table 2. FsQCA results.

Configuration	Solution				
	1	2	3	4	5
Knowledge Management & Learning	•	•	•	•	⊗
Innovation & Knowledge Transfer	•	•	•	•	•
Supply Chain Regulation & Conformance (Standards)		⊗		⊗	⊗
Economics of Environmentalism	⊗			⊗	⊗
Strategy & Structures (Values)	•	•	•	•	⊗
Isomorphic Change & Emulation	•	•	•	•	⊗
Consistency	0.83115	0.79493	0.80060	0.80092	0.79705
Raw Coverage	0.43921	0.35038	0.51269	0.33269	0.18730
Unique Coverage	0.01999	0.00461	0.11308	0.01192	0.02576
Overall solution coverage	0.597308				
Overall solution consistency	0.812238				

- transfer, strategy and structures, and isomorphic change and emulation, with the absence of supply chain, and the redundancy of regulation and conformance and economics of environmentalism. Core conditions are the presence of innovation and knowledge transfer and the absence of supply chain, combined as a causal configuration.
- Solution 3 combines the presence of knowledge management and learning, innovation and knowledge transfer, regulation and conformance, strategy and structures, and isomorphic change and emulation, with the redundancy of supply chain and economics of environmentalism. Core conditions are the presence of knowledge management and learning.
 - Solution 4 combines the presence of knowledge management and learning, regulation and conformance, strategy and structures, and isomorphic change and emulation, with the absence of supply chain and economics of environmentalism, and the redundancy of innovation and knowledge transfer. Core conditions are the presence of knowledge management and learning.
 - Solution 5 combines the presence of innovation and knowledge transfer, with the absence of knowledge management and learning, supply chain, regulation and conformance, economics of environmentalism, strategy and structures, and isomorphic change and emulation. Core conditions are the presence of innovation and knowledge transfer and the absence of supply chain, combined as a causal configuration, and the absence of isomorphic change and emulation.

The holistic model (see [Figure 1](#)) was drawn using three concentric layers to frame the content and antecedent requirements. The circle (layer) outside of the research question details the seven key themes detected in the literature review, which form items that would need to be evident for PSO practitioners to implement CE principles within their internal processes and operations, that would logically be displayed by PSOs should they implement any of the seven characteristic features. The data collection, from group participants, confirmed the seven key themes and the internal correlations and dependencies of the elements within each ring of the model. The outer circle (layer) details the elements or characteristics of a PSO that enable the key themes (requirements) to be enacted, and they are placed close to the seven key themes that they enable. For example, 'dedicated staff' could well be placed under several of the themes, but it was placed where it was deemed to have the strongest connection (i.e. strategy and structures). However, two different focus groups (independent of each other) mentioned that 'stakeholder engagement' should be added into the model to encompass sharing of values (i.e. value chains and value systems). Thus, the model was updated to include stakeholder engagement in the outer ring and has been linked to the supply chain theme. The four words that sit outside of the layers of the model were the external enablers (to the organization) that research participants mentioned as requirements or antecedents that can impact their implementation of CE within their internal processes and operations (Klein et al., 2020)

The overall solution coverage indicates the extent to which the five solutions explicate the outcome. Results

indicate an overall solution coverage of 0.60; this suggests that almost two thirds of the outcome can be explicated by the five solutions provided. The overall solution consistency indicates the level of sufficiency which should be above 0.75; with an overall consistency of 0.81, the solutions demonstrate high agreeability in leading to successful environmental sustainability and CE principles. Raw coverage for single solutions ranges from 0.19 to 0.51, with corresponding consistency ranging from 0.79 to 0.83, indicating that all solutions surpass the required threshold.

Discussion

Our fsQCA results confirm the need for core and peripheral conditions including retaining a relationship with the outcome of environmental sustainability and CE. Solutions 1–4 indicate that the presence of knowledge management and learning is a core condition; thus, whenever this condition is present, it retains high causal essentiality with the outcome of environmental sustainability. Walpole et al. (2024) evidence the significance of knowledge management and learning in the transition from a linear to a circular approach. Given that participants responding to this questionnaire were participating on a learning programme (Walpole et al., 2022) this finding evidences the conscious correlation of newly acquired knowledge with becoming more environmentally sustainable. Supporting Clifton et al. (2024), the results confirm that employee awareness is rising in support of a transition to total ownership of circularity by all staff. Interestingly, Ojiako et al. (2022) found that the internal dissemination of this knowledge significantly facilitated the implementation of CE principles and environmental management systems. This knowledge was found to be of greater significance than the diffusion of a CE in an organization's environment; however, fsQCA results indicate that isomorphic change and emulation is indeed present across solutions 1–4, revealing that this condition, despite its peripherality, may contribute more significantly to CE implementation, which supports the findings of Liu et al. (2024).

Furthermore, Solutions 2 and 5 reveal the presence of innovation and knowledge transfer and the absence of supply chain, combined as a causal configuration; this finding indicates that the presence of innovation and knowledge transfer must combine with the absence of supply chain to achieve environmental sustainability, supporting the assertions of Liu et al. (2022). In this circumstance, it may be the case that innovative methods are being introduced to stimulate system redesign in transitioning to a CE (Ripanti & Tjahjono, 2019). However, such innovation may not be replicated across the supply chain; the drive to improve the 3Rs and circular nature of supplies is reduced to a functional initiative by a small percentage of employees or centralized staff who are not immediately close to the workplace where value is added, and work is conducted. Hence, they may not immediately observe the innovation and knowledge transfer occurring, and such 'organizational distance' further inhibits innovation occurring within the supply chain for circular initiatives. Moreover, Walpole et al. (2022) and Clifton, De Laurentis, et al. (2024) note, for innovation and knowledge transfer to cause meaningful change in the transition to a CE, collaboration is necessary. This emphasises the need for

PSOs to cultivate more open dialogue and absorptive capacity across their organization as suggested by Liu et al. (2024). Initiatives such as the CEIC programme (Walpole et al., 2022; Liu et al., 2022) that enhance employee knowledge and skills appear to be useful in facilitating knowledge transfer. The data supports recent research that suggests that a triple helix approach, that facilitates knowledge transfer and co-production of CE solutions, can facilitate implementation of CE principles (Liu et al., 2022).

Given the absence of isomorphic emulation being a core condition within this solution, this further confirms that collaboration is necessary, as cases conforming to this solution may exhibit a reluctance to emulate the practices of partner organizations. As argued by Rashman et al. (2009), the requirement to assimilate and embed new knowledge may be influenced by organizational culture and practices, as well as shared meanings and routines. Hence, while knowledge transfer may be occurring, that knowledge is not being assimilated or emulated within the recipient PSOs. This is further confirmed by the absence of knowledge management and learning in Solution 5, confirming Rashman et al.'s (2009) findings that knowledge must be 'embedded' in the intellectual competence (of staff) and organizational culture.

Conclusion

The study results provide many interesting insights into the voids, words, and practices of PSOs and creates new academic insight into implementing CE within PSO operations. The public sector has engaged in significant change in recent times primarily to improve resource efficiencies and to minimize wastes. The current state of progress towards a CE is nascent and currently limited to waste collection, public procurement and carbon footprint reduction. Transformation of PSOs operating models is being hampered by a tactical, incremental, and emergent approach which risks eroding staff engagement as knowledge is not accompanied by actions. This position is natural as few mechanisms exist to help PSOs and a dearth of 'CE exemplars' for PSOs to emulate (isomorphic change) despite employee awareness of its importance.

We suggest that role models and exemplar organizations should be established and celebrated to 'show' what is achievable by delivering on environmental promises (vision), standards and elements of what a circular system is (such as the codified requirements of BS 8001 or ISO 14001:2015 EMS). These models should be implemented (adapt and adopt) by PSOs and their suppliers to create new processes and systems that support the vision of a new CE model. The implemented models should yield the improvement in metrics so desired by Droege et al. (2021) and Klein et al. (2022) to effectively harness the innovations of the large number of PSO employees and suppliers for the benefit of current and future generations.

Theoretical implications

This study provides several theoretical implications for the field of research surrounding CE implementation in the public sector. First, the study addresses the paucity of necessary elements to support implementation of CE principles in public sector internal processes and operations

at an organization level (Dagilienė et al., 2021; Klein et al., 2022). This study makes an important theoretical contribution and is the first to empirically analyse the Welsh public sector antecedents for CE implementation. This article answers the call of Klein et al. (2022) for research that explores CE implementation antecedents in PSOs in other regions of Europe. Given the unique context of Wales (as outlined above), a peripheral region, these findings are context-specific but do provide an important first step in revealing multiple existing pathways to achieving meaningful adoption of CE principles. Second, it makes use of the integrative framework developed by Klein et al. (2022) and focuses on the antecedents for implementation of CE principles within the internal processes and operations of PSOs at an organizational level, which they argue is key for the transition to a CE. The study also confirms the suggestions of Liu et al. (2022) that the triple helix model can support PSOs to implement CE principles within their organizations. The study suggests that the implementation of CE principles is complex and requires a collaborative approach with regional and national stakeholders and their organizational supply chains, consistent with the assertions of Clifton, Kyaw, et al. (2024).

This research presents a new model of PSO engagement with the CE and sustainability which is conceptually generated and empirically validated to address the historic limitations of previous authors who focused mainly on the metrics for CE performance evaluation (Droege et al., 2021) or focus on one perspective, for example local government (see Dagilienė et al., 2021). Droege et al. (2021) utilize organizational sustainability as a theoretical perspective for creating an organizational framework for public sector CE practices and strategies. Offering an alternative lens, this research delves into the underpinning antecedents of CE engagement and their interconnections through employing fsQCA. Cross-case analyses of causal 'recipes' for environmental sustainability of Welsh PSOs revealed unique integrations with their counterparts, and levels of co-dependency for CE outcomes. This study has also contributed a different methodological approach to studying CE implementation of large complex PSOs.

Practitioner implications

This article offers significant insights for practitioners in achieving 'net zero' 2030 targets (Welsh Government, 2021) and statutory obligations to implement the WFGA (Welsh Government, 2015) requirements. The study findings indicate innovation & knowledge transfer represents one of the most important conditions for implementing CE principles. Existing research indicates that PSOs are less familiar with promoting innovation, confirming Walpole et al.'s (2022) proposition that practitioners must increase organizational commitment to innovate by investing in practitioner-led intervention programmes that support organizational innovation capability. Open forms of innovation (Chesbrough, 2003) offer such opportunities for collaboration through inter-organizational partnerships with regional capacity building such that knowledge can be pooled, and investments transferred from innovators to adopters at much less risk and cost. Clifton et al. (2024) propose fostering a culture that focuses on stakeholders, is supported by sufficient resources, and pays attention to

maintaining formal and informal dialogues can support meaningful engagement and potential progress towards a more effective CE future state PSO model. Such formalized mechanisms, and the PSO contingent knowledge of attendees would allow an executive to sense that could be used to adapt existing systems.

Knowledge management and learning was a core condition for fsQCA solutions 1–4. This implies developing or recruiting new knowledge has high causal essentiality for CE achievement, which supports Liu et al.'s (2022) and Clifton et al.'s (2024) studies' findings. Introducing knowledge management processes implies 'mainstreaming' CE knowledge, not restricting it to individuals in the PSO.

Finally, the results show pressure should be exerted over supply chain partners to reduce their carbon footprint through environmentally sustainable practices, supporting Burke et al.'s (2023) study findings. New partner and supplier selection and creating new revenue streams for re-cradling will place an added pressure on public procurement staff. Innovation skills should be deployed to staff and purchasing should be pooled across organizations to support greater implementation of CE principles and encourage 'cradleability' in supplier design processes.

Limitations and future research

This study is grounded upon an analysis of perceptions and could be deemed subjective. There is potential bias from including participants who had demonstrated a commitment to implementing CE principles and so value could be derived from engaging individuals with less self-interest. Future research could replicate this study at a larger scale using quantitative methods to obtain more holistic perspectives for each PSO. A comparison of public versus private sector organizations should also be undertaken to identify the differences, as well as practices that can be transferred between contexts. A regional perspective is possible in the findings and so future studies could explore other regions to compare.

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