

The Mediating Role of Circular Economy and Moderating Role of Institutional Pressures on Service Innovation and Sustainable Development

Mohd Rizal Razalli^{1*}  | Alawee Lateh²  | Abdul Kafi³  | Alminnourliza Binti Noordin⁴  | Mohd Kamarul Irwan Abdul Rahim⁵ 

¹School of Technology Management and Logistics, College of Business, Universiti Utara Malaysia, Malaysia

²Department of Business Administration, Faculty of Management Sciences, Prince of Songkla University, Thailand

³School of Technology Management and Logistics, College of Business, Universiti Utara Malaysia, Malaysia

⁴School of Technology Management and Logistics, College of Business, Universiti Utara Malaysia, Malaysia

⁵School of Technology Management and Logistics, College of Business, Universiti Utara Malaysia, Malaysia

*Correspondence to: Mohd Rizal Razalli, School of Technology Management and Logistics, College of Business, Universiti Utara Malaysia, Malaysia.

E-mail: rizal@uum.edu.my

Abstract: This study examines how open and closed service innovations impact the United Nations Sustainable Development Goals (SDGs) within a local government ecosystem, evaluating circular economy (CE) practices as mediators and institutional pressures as moderators. Employing a proportionate stratified random sampling method, survey data was gathered from 155 municipal participants across Malaysia and analyzed using PLS-SEM. The findings reveal that both closed and open service innovations advance economic and social sustainability; closed innovation yields an insignificant environmental impact. Conversely, open innovation significantly drives all three sustainability dimensions. Crucially, CE practices serve as an indispensable partial mediator, transforming innovative public services into tangible resource loops. Furthermore, moderation analysis indicates that external normative pressure reinforces the link between collaborative open innovation and circular practices. However, regulatory demands exert no statistically significant moderating effect. Theoretically, this study advances Institutional Theory by demonstrating that normative stakeholder pressure, rather than coercive regulatory demand, drives public-sector CE adoption. Practically, it introduces a novel multidimensional framework for resource-constrained municipalities, empirically validating circular practices as the essential structural link that translates municipal service innovations into micro-level SDG implementation.

Keywords: Circular economy, regulatory pressure, service innovation, stakeholder pressure, sustainable development goals.

Article info: Received 13 May 2026 | revised 6 July 2026 | accepted 31 July 2026 | published 22 September 2026

Recommended citation: Razalli, M. R., Lateh, A., Kafi, A., Noordin, A. B., & Rahim, M. K. I. A. (2026). The Mediating Role of Circular Economy and Moderating Role of Institutional Pressures on Service Innovation and Sustainable Development. *Indonesian Journal of Sustainability Accounting and Management*, 10(2), 135–153. <https://doi.org/10.20448/ijSAM.v10i2.9390>



INTRODUCTION

Industrial development and ecological conservation are big challenges in today's world. The United Nations Sustainable Development Goals (SDGs) provide a clear set of goals, but the linear economy that was designed around the 'take-make-dispose' model keeps creating challenges to meaningful progress. Sustainability literature has primarily focused on manufacturing and physical innovation of products, whereas it is a fact that today's economies are essentially based on the provision of services. Consequently, service innovation is an important driver of organisational transformation, as it opens up possibilities for value creation without depleting natural resources (Chabowski, Gabrielsson, Hult, & Morgeson, 2025).

Service innovation involves developing new processes, services and/or business models, and focuses on functional outcomes and performance in service delivery, rather than simply the ownership of a product (Erdiaw-Kwasie, Owusu-Ansah, & Abunyewah, 2024). This change is not just a strategic move; it's a mandate for organisations aiming for sustainable and long-term resilience and regulatory compliance in the realm of sustainability (Razalli et al., 2024). However, the path from creating innovative services to achieving targets towards the SDGs is complex and often circuitous. The introduction of the concepts of circular economy (CE) is important in this relationship and the aim of this paper is to argue this. The circular economy is a paradigm shift towards the recycling of materials, waste minimisation and maximising resource use (Razalli et al., 2024). New forms of service structures, like sharing platforms, Product-Service Systems (PSS) and 'As-a-Service' are the service-operational catalysts. They promote the recovery of resources, continuous maintenance and the durability of the products, thereby contributing to circularity (Chabowski et al., 2025). These circular strategies enable service companies to link the necessary operational changes at the micro level with the macro-level SDG goals and targets of climate action (SDG 13) and responsible consumption (SDG 12) (Koval, Abramović, Đurović, Crvenica, & Arsawan, 2025).

Although similar literature exists on the role of institutional pressures on the private sector's eco-innovation pathways, there is limited empirical analysis of public service ecosystems, such as local governments. To date, studies that examine the organizational reaction to coercive and normative forces are predominantly found in manufacturing settings, and tend to make an implicit assumption that the response to both these forces is uniform (Mora-Contreras et al., 2023). Yet, municipal entities are constrained by administrative, budgetary and political pressures locally, which, in essence, change the nature of how external pressures shape innovative outcomes (Osei, Asante-Darko, & Quayson, 2024). A significant theory gap still exists on the active role these different institutional actors play in the diffusion of local service innovations into effective circular loops (Liu, Xing, Vendrell-Herrero, & Bustinza, 2024). To fill this gap, this study focuses on the micro-corporate rather than macro-corporate behaviours and operational aspects of developing municipal governance structures.

RQ1: How directly do Open Service Innovation (OPSI) and Close Service Innovation (CLSI) affect the aspects of Sustainable Development (SD)?

RQ2: To evaluate the mediating role of the Circular Economy (CE) in the process of connecting both open and closed innovation processes with local sustainability outcomes.

RQ3: To investigate the unique mediatory role of Regulatory Pressure (RP) and Stakeholder Pressure (SP) between both OPSI and CLSI and the strategic implementation of circular practices.

The central aim of this manuscript is to explore the complex dynamics of how open service innovation (OPSI) and closed service innovation (CLSI) help to achieve sustainable development in local government systems. It evaluates the difference between these different models of innovation and the effect they have on the triple bottom line, including the environmental (EVSD), social (SCSD) and economic (ECSD) aspects. The mediating role of CE in the process of converting innovative ideas into tangible, sustainable outcomes through the resource loops is one of the key questions that needs to be addressed. Moreover, the paper assesses the interaction of institutional expectations (RP and SP) and the integration of these innovation models and practices with circular practices. The overall goal of this research is to develop a comprehensive framework that shows how external pressures, resource limitations and strategic innovations are interrelated and how

the city can use them to develop a comprehensive sustainability strategy. Using an analytical point of view, the study uses Confirmatory Factor Analysis (CFA), then Dubey, Gunasekaran, and Ali (2015).

The paper is organised as follows: Section 2 interprets the literature so far reviewed. The theoretical aspects and the hypotheses that were formulated are described in Section 3. The research methodology detailed in Section 4 and data analysis and empirical findings in Section 5 break the data down. Last, Section 6 discusses the implications of the findings in this study, mentions some limitations of the research, and provides research directions.

LITERATURE REVIEW

As expressed in the modern definition of sustainable development, it is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The modern definition of sustainable development goes back to the important work of the Brundt Commission, which described sustainable development as development that fulfills the needs of the present generation without negatively affecting the availability of resources to future generations. This principle has grown to become the UN's comprehensive agenda (including 17 SDGs and 169 targets) that is the blueprint for the planet and its people. The progress in these areas is carefully monitored by the 'triple bottom line' (TBL), a combined measure of environmental protection, social justice and economic development. In this framework, both the private sector and public institutions are considered important actors for the change to make the transition from traditional industry to total sustainability (Dzhunushalieva & Teuber, 2024; Giovanardi, 2023; Mishra, Singh, & Rana, 2024; Suchitwarasan, Cinar, Simms, & Demircioglu, 2024).

The circular economy is an economic restorative mechanism designed to break the correlation between the use of limited resources and economic growth. This is done by replacing the traditional 'end-of-life' mindset with regenerative resource loops. The CE evolved from the concepts of industrial ecology in the 1970s to a strong multi-level operational methodology. It impacts on the national level in macro-level policies, on the eco-industrial networks in meso level and on the corporate business models in micro level with a focus on material recovery and reduction. This paradigm was initially promoted in manufacturing as a means of increasing remanufacturing and product durability, but it is very relevant in the service sector, mainly via 'servitisation' approaches. By using the 10Rs (refuse to reuse to regenerate), entities are enabled to keep the value of the resources. In the municipal sector and public service, the change is about reducing waste in operations and good citizen behaviours. Circular services are more likely to involve promoting renewable energy and reusing resources and technologies already in the community, rather than hardware construction, which is a big part of manufacturing. As such, the CE serves as a key link that transforms internal innovations into the wider environmental and social successes required by the SDGs, filling an important gap in the current literature (Koval et al., 2025; Tetteh, Atiki, Kyeremeh, Degbe, & Apanye, 2024).

Service innovation is the key to facilitating the transition towards a sustainable, circular future, and it is the means through which local authorities can address the complexities of the current governance landscape. Both open service innovation (OPSI) and closed service innovation (CLSI) play key roles in optimising the use of resources in public supply chains, whether by way of external partnerships or internal knowledge. But these innovations aren't working in isolation the success of them is largely dependent on the institutional context (Chabowski et al., 2025). In accordance with the Institutional Theory, entities are influenced by stakeholder pressures (SP) and regulatory pressures (RP), which determine the rate of adopting sustainable approaches (Ahmadov, 2023). Government mandates are coercive legal forces, while advocacy and citizens' demands are normative forces that give a 'social licence' to operate (Osei et al., 2024). These outside factors are very important moderators for municipalities, particularly in developing countries that have technological gaps and limited budgets. They can either help to speed up the integration of service innovation and circular practices, or they can drive more rigid compliance with social and legal standards in order to meet institutional standards. The lack of proper networking and technology can limit these entities significantly, making it imperative to

have a complete solution for the optimum performance of the supply chain (Khan & Khurshid, 2024; Suchitwarasan et al., 2024).

Closed innovation is the traditional approach in which an organization develops all technologies, services or products on its own. Companies that use this approach keep their own research and development and do not share their knowledge with outsiders. The basis of this model is that the company itself can build all the skills needed for growth, regardless of the need to merge with others. It is based on the premise that a company can develop the competencies it needs on its own without other companies. The main objective is to develop proprietary innovations, protect them from competitors and keep them confidential (Boscherini, Chiaroni, Chiesa, & Frattini, 2012).

On the contrary, innovation in a wider sense is about the creation of new services or new ideas that meet consumer needs and deliver economic benefits (Kogabayev & Maziliauskas, 2017). This can be a business-to-business or a business-to-consumer partnership or with an external ally and often takes place both ways. These co-creative networks can be described as an 'innovation ecosystem' (Granstrand & Holgersson, 2020). The term 'closed innovation' gained momentum with the work of Chesbrough and Crowther (2006), who emphasized the limitations of traditional, standalone R&D and suggested that companies in the 21st century should extend their thinking beyond their walls and internal resources to stimulate innovation and growth. Their research mainly defended the concept of open innovation, but at the same time clarified the definition, advantages and disadvantages of closed innovation. Closed models continue to be common today, particularly in areas where IP protection is key. However, in a changing commercial and technological environment, more and more organizations are turning to open and collaborative innovation as a means to help them grow and stay competitive.

In order to implement circular economy principles, organisations need to innovate (Kaipainen, Urbinati, Chiaroni, & Aarikka-Stenroos, 2022), often in the form of multiple service innovations (Engez, Ranta, & Aarikka-Stenroos, 2021). Many service innovations, including surplus food and used goods digital markets, waste management systems and recycling energy programmes, have successfully tackled sustainability issues and integrated circular approaches (Engez et al., 2021). In terms of service innovation, for instance, scarce resources, rising R&D costs, intense competition and the dynamism of knowledge are driving organisations into the open innovation paradigm. It is characterized by a series of resources and technology exchanges with different actors that take place within the boundaries of the cooperative, while avoiding the use of the closed model of cooperative (Barge-Gil, 2010; Chesbrough & Crowther, 2006; Naydenov, 2018; Stankevičienė & Nikanorova, 2020). However, it is not clear whether there are different impacts of open and closed service innovation models on realising SDGs and implementing the circular economy.

THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

The synergy between Service Innovation, Circular Economy and Sustainable Development. Effective service innovation – defined by the development of greatly improved service delivery systems, service concepts or technological interfaces – serves as a key dynamic capability. Unlike normal operational adjustments, SI enables municipalities to distinguish between the withdrawal of resources and the creation of value, and consequently reach an impact on the environmental, social and economic aspects of Sustainable Development (SD) directly.

Closed Service Innovation focuses on using proprietary knowledge and developing ideas internally to increase efficiency. As far as circularity, CLSI empowers local governments to make their own operations more efficient and reduce their energy consumption and waste. Even with managerial control and in-house research and development, public organisations can conduct “eco-efficiency” measures such as the upgrading of public infrastructure for energy efficiency or the digitisation of documents and related paperwork.

To adopt Open Service Innovation (OPSI), knowledge has to be intentionally shared and transferred across organisational boundaries, accelerating innovation through collaboration with NGOs, the private sector and citizens. Circular economy challenges are often system-level in nature and are not confined to one institution but require vast ‘system-level’ changes. OPSI allows municipalities to leverage resources from outside of their municipality to address these multifaceted problems, including starting recycling programs at

the community level or developing industrial symbiosis networks (where one organisation's byproduct becomes another's resource). Khan and Khurshid (2024) have found that one of the critical challenges for public and private institutions is to integrate external data with internal data analytics in order to successfully implement circular practices that result in sustainable outcomes. This helps to reinforce the notion of collaborative innovation needed to close big material loops Figure 1 illustrates the theoretical framework of this study.

The shift towards a circular economy cannot be achieved with just technological improvements; it will take more than economic models. Public policy should therefore play a role in reinforcing the wider innovation system to facilitate the creation of new circular projects by companies and their integration with the SDGs (Brás & Robaina, 2025). There are also foundational systematic reviews in the field that highlight the importance of public environmental research and development (R&D) as a key enabler for bringing about broader economic system transition, such as for small and medium enterprises to adopt circular models (Suchek, Fernandes, Kraus, Filser, & Sjögrén, 2021). The public sector organization is best situated to harness CE transitions as its primary task is to provide social and public value. Nevertheless, there is limited evidence from the literature that CE is being applied in these organisations, partly because of the lack of innovation capacity in the organisations themselves, and partly because of the complex institutional pressures that is likely to be present (Walpole, Bacon, Malik, & Rich, 2025). Thus, the following hypotheses are advanced:

H_{1a}: Closed service innovation (CLSI) exerts a positive influence on the adoption of the circular economy (CE).

H_{1b}: Open service innovation (OPSI) exerts a positive influence on the adoption of the circular economy (CE).

Economic dimension of sustainable development (ECSD), Service innovation contributes to economic sustainability by reducing the long-term costs and maximising working productivity. This can be achieved and the reduction in administrative costs can be realized through the adoption of e-government platforms and the implementation of smart delivery. The literature from Calabrese, Costa, Haqbin, Levaldi Ghiron, and Tiburzi (2024) and Mahajan and Kumar (2025) supports the fact that service innovation is a key tool that enables the government to create value at minimum cost for economic goals.

Social dimensions of sustainable development (SCSD), service innovation is one of the tools to foster equity and inclusiveness. Inventions such as digital community feedback systems, telemedicine and virtual education create new opportunities and remove old barriers, ensuring that marginalised groups have access to critical public services. According to Webster and Pascucci (2024), these social innovations make significant contributions to the SDGs, ensuring equitable access to resources, enhancing labour conditions, and improving the quality of life for communities.

Environmental dimension of sustainable development (EVSD), Service innovation drives 'dematerialisation', moving consumption from physical products to immaterial services (e.g., Product-Service Systems). This is a significant reduction in material footprints and resource recovery. According to Boon, Wynen, and Callens (2023), green service innovations can effectively mitigate the environmental costs while offering satisfactory financial returns, and innovation is crucial to achieve target 12 of SDG.2023. Boon et al. (2023) state that innovation is essential to achieve SDG.2023.12 and that green service innovations are effective when balancing environmental costs and financial performance. Moreover, the digitalisation of public services directly relates to a reduction in carbon intensity and energy use. Therefore, the following are hypothesised.

H_{2a}: Closed Service innovation (CLSI) positively influences the economic dimension of sustainable development.

H_{2b}: Closed Service innovation (CLSI) positively influences the social dimension of sustainable development.

H_{2c}: Closed Service innovation (CLSI) positively influences the environmental dimension of sustainable development.

H_{3a}: Open Service innovation (OPSI) positively influences the economic dimension of sustainable development.

H_{3b}: Open Service innovation (OPSI) positively influences the social dimension of sustainable development.

H_{3c}: Open Service innovation (OPSI) positively influences the environmental dimension of sustainable development.

The Mediating Role of the Circular Economy

Service Innovation offers the tools and expertise to identify and pursue new opportunities, while the Circular Economy is the tool that is going to make them a real sustainable accomplishment. Innovation could otherwise just improve the basic efficiency without addressing the fundamental sustainability problems without a circular model (such as remanufacturing and recycling). For this reason, CE is seen as the enabler to make SI 'real' to the triple bottom line.

All of the CLSI focuses on internal oversight. Councils create their own resource optimisation protocols when they are using CLSI. The CE acts as a mediator, providing concrete and actionable solutions, such as implementing energy recovery systems or refurbishing assets, that can be used to put these concepts into practice. CLSI creates circular practices (e.g., extending the life of city equipment), which reduces procurement costs, thus helping to moderate economic sustainability. Internal waste management ideas can only be realized if they become actual circular loops (e.g., Zero Waste regulations) directly in line with environmental goals. Similarly, the use of internal digital instruments to enable the transfer of surplus resources to local community centres will improve social equity. This idea of mediation is supported by recent literature, which suggests that innovative capabilities are the key drivers of sustainable performance, enabling CE practices (Phonthanakitithaworn, Srisathan, & Naruetharadhol, 2024; Triguero, Cuerva, & Sáez-Martínez, 2022).

On the other hand, OPSI is dependent on external partnerships. In this place, CE is the foundation for community engagement and 'industrial symbiosis'. Shared circular value chains are the outcome of external OPSI concepts and deliver better sustainability results. OPSI brings partners together to create resource-sharing platforms, which not only reduces the financial burden on the government but also increases the local economy (see Table 1). Innovations that are developed collaboratively provide for large regional recovery systems, which no single municipality would be able to run on its own, and create huge environmental benefits. Moreover, by engaging citizens in the process of innovation of sharing economies, the citizens themselves become strengthened in the sense of social resilience. The path from innovative capacity to true performance is mediated and reliant on the critical implementation of circular strategies, in line with Tetteh et al. (2024). Therefore:

H_{4a}: Circular economy (CE) mediates the relationship between Closed Service innovation (CLSI) and the economic dimension of sustainable development.

H_{4b}: Circular economy (CE) mediates the relationship between Closed Service innovation (CLSI) and the social dimension of sustainable development.

H_{4c}: Circular economy (CE) mediates the relationship between Closed Service innovation (CLSI) and the environmental dimension of sustainable development.

H_{5a}: Circular economy (CE) mediates the relationship between Open Service innovation (OPSI) and the economic dimension of sustainable development.

H_{5b}: Circular economy (CE) mediates the relationship between Open Service innovation (OPSI) and the social dimension of sustainable development.

H_{5c}: Circular economy (CE) mediates the relationship between Open Service innovation (OPSI) and the environmental dimension of sustainable development.

Table 1: Comparative Analysis of Closed and Open Service Innovation Paradigms in the Public Sector

Dimension	Closed Service Innovation	Open Service Innovation	Sources
Knowledge Governance	Inward-focused; relies on internal administrative R&D and intra-organisational expertise.	Bi-directional; leverages external knowledge from citizens, private firms, and universities.	Clifton, Kyaw, Liu, and Walpole (2024); Jesus, Jugend, de Camargo Fiorini, and de Sousa Mendes (2025);
CE Operational Efficacy	Highly constrained; fails to address the systemic, cross-boundary nature of closed-loop material flows.	Highly effective; facilitates the orchestration of Open Service Innovation.	Awan, Shamim, Rahman, and Aydin (2026); Dorrego-Viera,

Dimension	Closed Service Innovation	Open Service Innovation	Sources
Service Design & Delivery	Top-down: public services are conceptualised internally and delivered unilaterally to the public.	Co-created public services are co-designed via public-private partnerships and communities of practice.	Urbinati, and Lazzarotti (2026); Clifton et al. (2024)
Primary Systemic Barriers	Rigid institutional structures, technological lock-in, and ingrained administrative inertia.	Network governance complexities and conflicting statutory audit obligations.	(Awan et al., 2026) and Walpole et al. (2025)

The Impact of Circular Economy on Triple Bottom Line

Economically, scholars note that CE practices like resource recovery stimulate growth by fostering innovative business models and reducing operational costs (Korhonen, Nuur, Feldmann, & Birkie, 2018). Socially, transitioning to circular frameworks enhances community well-being and drives localized job creation within the recycling and remanufacturing sectors (Murray, Skene, & Haynes, 2017). Environmentally, CE methodologies mitigate ecological degradation by minimizing virgin resource extraction, lowering emissions, and systematically designing out waste (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). Collectively, these interrelated studies confirm that adopting a circular economy acts as a comprehensive, multidimensional driver for holistic sustainability. Therefore,

H_{6a}: Circular economy (CE) positively influences the economic dimension of sustainable development.

H_{6b}: Circular economy (CE) positively influences the social dimension of sustainable development.

H_{6c}: Circular economy (CE) positively influences the environmental dimension of sustainable development.

The Moderating Role of Regulatory Pressure

Organisations are under 'coercive isomorphism' due to the government 'norms' and legal requirements that compel conformity with social norms (DiMaggio & Powell, 1983). Regulatory pressure (RP) includes EPR schemes, disposal bans, and environmental laws, which set critical boundaries. We suggest that the regulatory pressure makes the association between service innovation and CE adoption even tighter by moving the focus of innovation from commercial gain to meeting sustainability requirements to comply with regulations.

In severe cases, municipalities are forced to prioritize meeting a specific requirement, such as creating energy audit procedures or hazardous waste protocols, in their CLSI. With no pressure, innovation from the inside could be merely a matter of speed, rather than of circularity. Similarly, regulatory requirements can drive OPSI by creating a demand for green solutions. Cities with the toughest landfill reduction requirements are more likely to collaborate with an external technology provider to build a circular tracking platform. In fact, recent research has shown that strict rules significantly speed up the uptake of new knowledge and practices into the market by compelling businesses to learn new things to adhere to the law (Clifton et al., 2024; Giannetti et al., 2023). The information provided led to the following hypotheses being suggested.

H_{7a}: Regulatory pressure (RP) positively moderates the relationship between Open Service innovation (OPSI) and Circular economy (CE).

H_{7b}: Regulatory pressure (RP) positively moderates the relationship between Closed Service innovation (CLSI) and Circular economy (CE).

The Moderating Role of Stakeholder Pressure

Regulations are the 'floor' of the performance, while Stakeholder Pressure (SP) from local communities, NGOs and citizens is the 'ceiling' and provides the social licence to operate. Normative pressure is a term used in Institutional Theory. This research argues that stakeholder pressures result in municipalities making a significant effort to demonstrate ethical responsibility and operational transparency through innovative strategies, which, in turn, boost their drive for the circular economy.

Local governments will be vigilant about updating their internal processes into easily observable and quantifiable demonstrations of sustainability – when they are under intense public pressure to demonstrate sustainability, like when community members demand that parks and recreation be located where they don't disrupt neighborhoods, for instance – as they tackle intense public pressure to demonstrate sustainability, they will take careful aim at CLSI. Moreover, stakeholder pressure is a strong inciter to OPSI. Residents' pressure on governments to give them a say in civic decisions forces governments to adopt participatory budgeting for environmental projects, democratising their innovation pipelines.

Pressure from outside, often more than internal motivations, can be more effective at driving CE adoption, particularly when institutions are looking for community legitimacy (Ahmadov, Durst, Gerstlberger, & Nguyen, 2025). Moreover, as observed by Hernández-Arzaba, Nazir, Leyva-Hernández, and Muhyaddin (2022), the pressure posed by stakeholders stimulates organisations to go beyond symbolic greenwashing and adopt innovation in order to implement a circular approach.

H_{8a}: Stakeholders' pressure (SP) positively moderates the relationship between Open Service innovation (OPSI) and Circular economy (CE).

H_{8b}: Stakeholders' pressure (SP) positively moderates the relationship between Closed Service innovation (CLSI) and Circular economy (CE).

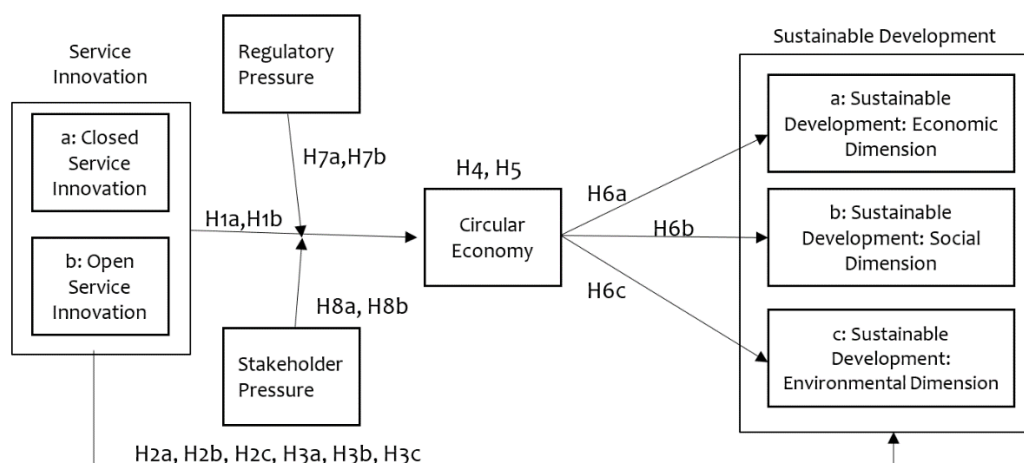


Figure 1. The theoretical framework of the study

MATERIAL AND METHODS

Research Sample

The empirical study for this study was carried out in the local government field in Malaysia. This country is a unique study area as it has made a conscious effort towards developing its service innovation capabilities in recent years (Newaz, 2022). Malaysia has been ranked as having an 'upper-middle' capacity, placing it in the list of countries with great potential to become more innovative, according to the World Intellectual Property Organization (2025). In order to provide a representative sample from among the various levels of government, this study used a proportionate stratified random sampling technique. The population was categorized into four groups: City councils (12% of 19); Municipalities (26% of 40); District councils (59% of 92); and Modified local authorities (3% of 4, 155). The sampling distribution of the sample represents the percentage distribution of the target population exactly, which minimizes the sampling error and provides good group representation (Hair, Risher, Sarstedt, & Ringle, 2019). The total number of survey questionnaires distributed to the target population for the stratified administrative categories is 155. Of which, 86 questionnaires were returned and verified as complete data and used for analysis, which resulted in a usable data rate of 55.48%. Babbie (2020) believes that a response rate of more than 50% is acceptable and adequate for social science analysis. Moreover, the sample size of the study ($N = 86$) was slightly lower than the calculated ideal sample size ($n =$

113), but was still adequate for the rigorous sample size requirement of the Partial Least Squares Structural Equation Modeling (PLS-SEM). Considering that the maximum number of structural paths toward the endogenous constructs of the conceptual model, the sample size is significantly larger than the '10 times rule' and the minimal size of the sample required by Hair et al. (2019) to obtain a power of the tests above 90%. All participants gave informed consent and the investigators adhered to ethical guidelines, obtaining official clearance from the appropriate institutions. As far as the participants' professional positions are concerned, 1.33% were Mayors, 25.33% were Department Heads, 20% were Deputy Heads, 9.33% were Assistant Heads while the remaining 44% were general staff members. Professional experience in the respective organisations: 10.67% felt they had less than five years, 22.7% had between five and ten years, 36% had between 11 and 20 years, and 28% had more than 20 years.

Measurement Instruments

The instruments used to measure the items were adapted from existing validated instruments. To guarantee strong validity and reliability, the creation of the questionnaire adhered to the paradigm established by Churchill (1979). The survey was designed to begin with demographic items, followed by assessing the dependent and independent variables and end with items assessing the moderating pressures. A Likert Scale of five was used to record the responses of the participants. A two-stage validation and reliability testing of the research instrument were conducted prior to the full implementation to assure the strength and appropriateness of the instrument. The questionnaire's content validity was initially tested by a content validation review panel consisting of five subject matter experts. Literature in the field of method suggests that the panel size of this magnitude is quite suitable for the purpose of rigorously evaluating the relevance, clarity and comprehensiveness of the items; in this regard, a strong Content Validity (Lynn, 1986; Polit & Beck, 2006) can be calculated. After taking into account the suggestions from the experts, a pilot study was carried out with a preliminary sample of 30 participants to check the instrument's internal consistency and to detect any practical problems in terms of item understanding. A pilot sample size of 30 is commonly acknowledged as a sample size that is adequate and methodologically sound for determining preliminary reliability coefficients, such as Cronbach's alpha, as well as to ensure that the design of the survey is feasible before final data collection (Johanson & Brooks, 2010). The final structural model includes five different constructs. In particular, Service Innovation was operationalized as a first-order construct with 11 items adapted from Erdiaw-Kwasie, Abunyewah, Yusif, and Erdiaw-Kwasie (2023) and Martinez-Conesa, Soto-Acosta, and Carayannis (2017). To assess stakeholder and regulatory pressures, five items for each construct were adapted from Osei et al. (2024). Sustainable development was measured based on 15 items from Rodríguez-Espíndola et al. (2022) and Dey, Malesios, De, Chowdhury, and Abdelaziz (2020). Last, the implementation of the circular economy was measured based on five items, which were adapted from Koval et al. (2025).

EMPIRICAL FINDINGS

Partial Least Squares Structural Equation Modelling (PLS-SEM) with SmartPLS 4 software was used to test the conceptual model proposed in this study. The analysis was done in two steps: first, the measurement model was evaluated and second, the structural model was evaluated. The first phase confirmed the psychometric validity of the constructs, while the second phase enabled the hypotheses to be tested. To ensure internal consistency of the items, the researchers computed the composite reliability and the Cronbach's alpha coefficient. Rigorous tests regarding construct validity were carried out in terms of discriminant and convergent validity. Average Variance Extracted (AVE) and indicator loadings were used to evaluate the convergent validity. For the purpose of determining discriminant validity, a dual approach was used, including the Heterotrait-Monotrait (HTMT) ratio and the Fornell-Larcker criterion, to ensure that each latent variable was statistically different in the model.

Evaluating the Measurement Model

A preliminary check of the assumption of normality was necessary in order to determine whether to use a non-parametric or parametric data analysis technique to proceed with the main data analysis. To test the data for normality, skewness and kurtosis were calculated using SPSS and it was found that the data were normally distributed. Then, a confirmatory factor analysis (CFA) was performed to validate the reliability, discriminant validity and convergent validity of the constructs. The results of composite reliability (CR) and Cronbach's alpha (CA) are shown in Table 2. The alpha scores ranged from 0.756 to 0.905 and the CR scores ranged from 0.763 to 0.909. These values are all above the recommended 0.70, thus they provide strong evidence of the high reliability of these scales. Additionally, convergent validity was supported by the fact that the item loadings for the indicators were generally above 0.70. In evaluating the outer loadings of the measurement model, item RP1 and item SI11 were dropped due to loadings below the recommended level of 0.70. Following the exclusion of these items that were not performing well, the data set was considered adequate for further analysis because the AVE fulfilled all expectations. Two approaches were used to rigorously test the discriminant validity. According to Fornell and Larcker (1981), this approach involves having the AVEs for latent variables larger than their squared correlation with the other latent variables in the framework. The data in Table 3 show that all constructs are true to this condition. Furthermore, the values of HTMT were checked according to the method proposed by Henseler, Hubona, and Ray (2016). These results were shown in Table 4, and ranged from 0.430 to 0.875, which were all well below the stringent limit of 0.90. Overall, the findings provide strong support for the discriminant validity and the basic validity of the constructs used in the study.

Table 2: Reliability and validity assessment

Constructs	Items	Mean	S.D.	Loadings	AVE	Cronbach's alpha	Composite reliability (rho_a)
OPSI	SI2	4.33	0.723	0.755	0.557	0.803	0.804
	SI3	4.32	0.64	0.811			
	SI4	4.41	0.572	0.832			
	SI5	4.4	0.569	0.804			
CLSI	SI6	4.23	0.727	0.772	0.669	0.756	0.763
	SI7	3.97	0.805	0.781			
	SI8	3.53	1.044	0.720			
	SI9	3.75	0.96	0.869			
CE	SI10	3.79	0.827	0.858	0.684	0.882	0.889
	CE1	4.25	0.595	0.762			
	CE2	4.24	0.633	0.893			
	CE3	3.96	0.813	0.858			
ECSD	CE4	4.11	0.649	0.923	0.683	0.882	0.884
	CE5	3.95	0.769	0.846			
	SD1	4.25	0.572	0.760			
	SD2	4.15	0.608	0.924			
SCSD	SD3	4.16	0.616	0.867	0.726	0.905	0.909
	SD4	4.15	0.63	0.893			
	SD5	3.99	0.744	0.841			
	SD6	4.2	0.593	0.898			
EVSD	SD7	4.19	0.586	0.856	0.630	0.851	0.858
	SD8	4.07	0.664	0.828			
	SD9	4.13	0.622	0.920			
	SD10	4.09	0.597	0.925			
	SD11	4.36	0.607	0.788			
	SD12	4.15	0.586	0.872			
	SD13	4.23	0.559	0.929			
	SD14	4.09	0.597	0.847			
	SD15	4.12	0.657	0.826			

Note: CLSI: closed service innovation, OPSI: open service innovation, CE: circular economy, ECSD: sustainable development economic dimension, SCSD: Social dimension of sustainable development, EVSD: environmental dimension of sustainable development.

Table 3: Discriminant Validity - Fornell & Larcker Criterion

Constructs	CE	CLSI	ECSD	EVSD	OPSI	SCSD
CE	0.827					
CLSI	0.366	0.818				
ECSD	0.741	0.47	0.826			
EVSD	0.752	0.369	0.777	0.793		
OPSI	0.399	0.16	0.544	0.557	0.747	
SCSD	0.657	0.404	0.776	0.759	0.544	0.852

Note: CLSI: closed service innovation, OPSI: open service innovation, CE: circular economy, ECSD: sustainable development economic dimension, SCSD: Social dimension of sustainable development, EVSD: environmental dimension of sustainable development.

Table 4: Discriminant Validity –HTMT

Constructs	CE	CLSI	ECSD	EVSD	OPSI	SCSD
CE						
CLSI	0.430					
ECSD	0.833	0.564				
EVSD	0.844	0.431	0.875			
OPSI	0.458	0.237	0.643	0.658		
SCSD	0.728	0.471	0.867	0.851	0.628	

Note: CLSI: Closed service innovation, OPSI: Open service innovation, CE: Circular economy, ECSD: Sustainable development economic dimension, SCSD: Social dimension of sustainable development, EVSD: Environmental dimension of sustainable development.

Table 5 assesses the potential threat of common method bias (CMB) in this study; a full collinearity assessment approach was executed using Structural Variance Inflation Factors (VIF) as recommended by Kock (2015). This technique is considered a robust and modern alternative to traditional approaches like Harman's single-factor test in PLS-SEM. Path-specific VIF values greater than 3.3 indicate potential systematic variance inflation and the presence of CMB. As illustrated in the structural model analysis, the inner VIF values for all constructs ranged between 1.027 and 1.284. Because the maximum VIF value (1.284) is substantially below the conservative threshold of 3.3, it can be confidently concluded that common method bias does not pose a threat to the validity of the structural findings.

Table 5: Common method bias using Structural Variance Inflation Factors (VIF)

Constructs	VIF
CE -> ECSD	1.284
CE -> EVSD	1.284
CE -> SCSD	1.284
CLSI -> CE	1.027
CLSI -> ECSD	1.135
CLSI -> EVSD	1.135
CLSI -> SCSD	1.135
OPSI -> CE	1.027
OPSI -> ECSD	1.164
OPSI -> EVSD	1.164
OPSI -> SCSD	1.164

Evaluating the Structural Model

The measurement model was first tested, and then the structural paths were analysed using Structural Equation Modelling (SEM). As detailed in Table 6, the framework has high explanatory power with 43.5% of variance in social dimension, 55.5% in the economic dimension and 56.6% in the environmental dimension. The

cross-validated redundancy (Q^2) was used to measure the prediction power of the model beyond the coefficient of determination (R^2). The scores of Q^2 above zero indicate predictive relevance, which is confirmed here for social performance (0.393), environmental performance (0.375) and economic performance (0.421).

Furthermore, Table 6 shows that closed service innovation (CLSI) is significantly associated with sustainable development in terms of the economic and social dimension (both $\beta > 0.2$, $p < 0.05$), but the environmental impact is not as significant ($\beta > 0.1$, $p > 0.05$). Open service innovation was found to have strong and significant correlations with the economic dimension ($\beta = 0.292$, $p < 0.01$), social dimension ($\beta = 0.332$, $p < 0.01$) and environmental dimension ($\beta = 0.304$, $p < 0.01$) of sustainable development. Thus, the main hypothesis is confirmed as service innovation can effectively drive sustainable development.

Then the correlation between CLSI and circular economy (CE) was analysed. The findings indicated a significant relationship ($\beta = 0.311$, $p < 0.01$), which supports the related hypothesis. The relationship between OPSI and CE was also investigated and found to be quite significant ($\beta = 0.349$, $p < 0.01$). In addition, the researchers assessed the impact of implementing CE in the local governments of Malaysia on sustainable development.

The evidence pointed to a statistically significant impact of CE on the economic ($\beta = 0.543$, $p < 0.01$), social ($\beta = 0.457$, $p < 0.01$), and environmental ($\beta = 0.593$, $p < 0.01$) dimensions. This validates the hypothesis and makes an important point that service innovation is still a huge challenge to enable the implementation of circular economy practices in this sector. The mediating effect of the CE implementation on the relationship between service innovation (both CLSI and OPSI) and sustainable development was also tested. According to Table 6, a significant indirect effect was obtained. Specifically, partial mediation was confirmed for the connection between CLSI and SD in the economic ($\beta = 0.169$, $p < 0.05$), social ($\beta = 0.142$, $p < 0.05$) and environmental ($\beta = 0.184$, $p < 0.05$) domains.

CE also helped to mediate the link between OPSI and the three pillars of sustainable development. The overall impact of CE on the economic ($\beta = 0.189$), social ($\beta = 0.160$) and environmental ($\beta = 0.207$) elements of SD was found to be significant, as shown in Table 7. Finally, the four core mediation hypotheses were all supported empirically. Hence, it is evident that the effectiveness of CLSI and OPSI is able to improve the performance of sustainable development of municipalities, but the integration of the circular economy is needed to get to the best results.

Table 6: Significant results of the structural path coefficients

Hypothesis	Relationship	Path coefficients	T-values	P-values	Significant level	Decision
H1a	CLSI->CE	0.311	2.474	0.007	*	support
H1b	OPSI->CE	0.349	3.407	0.000	*	support
H2a	CLSI->ECSD	0.224	2.606	0.005	*	support
H2b	CLSI->SCSD	0.183	1.973	0.024	*	support
H2c	CLSI->EVSD	0.103	1.150	0.125	-	Not support
H3a	OPSI->ECSD	0.292	2.722	0.003	*	support
H3b	OPSI->SCSD	0.332	3.251	0.001	*	support
H3c	OPSI->EVSD	0.304	3.549	0.000	*	support
H6a	CE->ECSD	0.543	5.660	0.000	*	support
H6b	CE->SCSD	0.457	4.142	0.000	*	support
H6c	CE->EVSD	0.593	6.918	0.000	*	support
R ² Values	ECSD=0.555	SCSD=0.566	EVSD=0.435			
Q ² Values	ECSD=0.421	SCSD=0.375	EVSD=0.393			

Note: OPSI: Open service innovation, CLSI: Close service innovation, CE: Circular economy, ECSD: Economic Sustainable Development, SCSD: Social Sustainable Development, EVSD: Environmental Sustainable Development.

Table 7: Summary of indirect relationship results (Mediation)

Hypothesis	Total Effect		Direct Effect		Indirect Effect			P-Value	Decision
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	SD	T-Value		
CLSI -> CE -> ECSD	0.311	0.007	0.543	0.000	0.169	0.071	2.390	0.008	Supported
CLSI -> CE -> SCSD	0.311	0.007	0.457	0.000	0.142	0.064	2.223	0.013	Supported
CLSI -> CE -> EVSD	0.311	0.007	0.593	0.000	0.184	0.077	2.396	0.008	Supported
OPSI -> CE -> ECSD	0.349	0.000	0.543	0.000	0.189	0.070	2.723	0.003	Supported
OPSI -> CE -> SCSD	0.349	0.000	0.457	0.000	0.160	0.066	2.399	0.008	Supported
OPSI -> CE -> EVSD	0.349	0.000	0.593	0.000	0.207	0.066	3.118	0.001	Supported

Note: OPSI: Open service innovation, CLSI: Close service innovation, CE: Circular economy, ECSD: Economic Sustainable Development, SCSD: Social Sustainable Development, EVSD: Environmentally Sustainable Development.

Moderation Analysis

Empirical support was found for only one of the hypotheses, namely, hypothesis H8a. This particular hypothesis tested the interaction of stakeholder pressure (SP) and the relationship between OPSI and the use of CE practices. Without any moderators, the R² value for CE was 0.325, which implies that OPSI and SP explain 32.5% of the variation in CE. The inclusion of the interaction term raised this R² value to 0.638 (63.8%), which was a significant improvement of 31.3% of variance explained. An examination of the meaning of this effect showed a positive and significant moderating effect between OPSI and CE adoption ($b = 0.406$, $p < 0.015$). This finding backs up H8a and highlights a strong reinforcement of collaborative open innovation and circular practices when stakeholder pressure is increased. The result of the analysis does not support hypothesis H7a or H7b, but it does indicate that the relationship in this ecosystem is not simply enough regulated by regulatory pressure. This could be due to policy weaknesses in structure and implementation, suggesting that intrinsic incentives or networks are more influential than regulation. For the type of innovation proposed in H8b, it is probable that this relationship was not present as the specific features of innovation did not correspond with the strategic priorities of the sample, or external market forces were counteracting the effect. The findings on the level of moderation are summarized in Table 8.

Table 8: Summary of Moderation Effect

Hypothesis	Relationship	Path coefficients	t-values	p-values	Decision
H7a	RP x OPSI -> CE	-0.15	0.993	0.160	Not supported
H7b	RP x CLSI -> CE	-0.093	0.428	0.334	Not supported
H8a	SP x OPSI -> CE	0.406	2.172	0.015	Supported
H8b	SP x CLSI -> CE	0.134	0.739	0.230	Not supported

Note: OPSI: Open service innovation, CLSI: Close service innovation, CE: Circular economy, ECSD: Economic Sustainable Development, SCSD: Social Sustainable Development, EVSD: Environmentally Sustainable Development, SP: Stakeholder pressure, RP: Regulatory Pressure.

Table 9: Goodness-of-fit indices: Saturated model and Estimated model

Measure	Saturated model	Estimated model	Reference Standard	Interpretation
SRMR	0.076	0.078	0-0.08	Good
NFI	0.924	0.921	0.9-1.0	Good

The global model fit of the saturated model, the Standardised Root Mean Square Residual (SRMR) and the Normed Fit Index (NFI) were evaluated for each model (Hair et al., 2019). The SRMR reflects the basic mismatch between the observed and the model-implied correlation matrices. The estimated model obtained an SRMR value of 0.078, which was well below the universally accepted conservative value of 0.08 (Hu & Bentler, 1999), indicating an excellent fit and little possible specification error. Likewise, the NFI calculates the relative goodness of fit of the proposed model to a null model. The estimated model showed an NFI of 0.921, which is above the recommended academic level of 0.90 (Hair et al., 2019). Most importantly, the marginal difference in the model measures (SRMR = 0.076; NFI = 0.924) between the saturated and estimated model indicates that the hypothesized structural path configurations are very similar to the empirical data structure. All these diagnostic indices indicate that the model has an acceptable overall fit and strong explanatory validity, which fulfills the necessary conditions for the interpretation of structural path coefficients in Table 9.

DISCUSSION, IMPLICATION AND CONCLUSION

The study is valuable for filling an important gap in the academic discussion on the intersection between Sustainable Development (SD), Circular Economy (CE) and Service Innovation (SI) in local government contexts, as it is an empirical study. While previous research has validated the individual benefits of circularity and innovation, little has been explored related to the combined benefits of circularity and innovation under stakeholder and regulatory pressures. This study's findings confirm that SI is a significant contributor to sustainable development with regard to the environmental, social and economic aspects. This indicates its large strategic value as one of the core capacities in order to achieve institutional performance and viability, similar to previous studies by Harikannan, Vinodh, and Antony (2025) and Bag, Yadav, Wood, Dhamija, and Joshi (2020). The CE was also found to have a strong and independent effect on all of these factors. For a holistic sustainability strategy, implementing CE becomes important because it generates social advantages with refurbishment jobs, reduces ecological impacts by reducing waste and brings financial advantages through resource efficiency. This is in line with the previous findings of Ghisellini, Cialani, and Ulgiati (2016) and Kirchherr, Reike, and Hekkert (2017).

Importantly, this investigation shows there is a partial mediation effect with the CE. This is because SI does more than simply help in the direct enhancement of sustainability; it is a key enabler of circular operations. There is a synergy effect in which the investment of resources in the SI contributes to increasing the ability of the municipality to implement the circular strategies, such as the sharing platform, digital waste monitoring, etc., which amplify the overall sustainable development results. The lessons learned here emphatically indicate that it's time to separate the ideas of circularity and innovation and stop thinking of them as unrelated. Rather, they are required to combine them into a unified strategic plan. Local authorities can use the same two forces of SI to achieve the ambitious, multi-dimensional goals outlined in the Sustainable Development Goals (SDGs) (Ellen MacArthur Foundation, 2017) if they recognise that SI is a practical tool for putting circularity into action.

Theoretical Implications

This paper is a continuation of the literature on service innovation by incorporating Institutional Theory as a way for municipal bodies to use this innovation in order to reach sustainable development. Firstly, the research has questioned the traditional and single-dimensional view of sustainability by introducing the multidimensional sustainability structure, which creates the separateness of social, environmental and economic aspects. Therefore, this research is one of the first empirical studies that offers evidence of the mediating effect that the circular economy brings between service innovation and these two separate outcomes. This provides a deeper understanding of the value creation processes in public service networks and explains their effects on sustainable development (which is hardly explored in local government settings). The authors contend that sustainable development is a key performance metric and is crucial for long-term survival and legitimacy of municipal organisations. The paper breaks away from much of the previous research that has concentrated on the issue of corporate performance in general and demonstrates that service innovation can be as important as the other areas in achieving complex sustainability goals. Further, the study

extends the Institutional Theory by identifying key moderating factors: stakeholder and regulatory pressures. This highlights the importance of externalities shaping the effectiveness of innovation approaches and offers new theoretical insights into the functioning of the public sector in the context of limited financial resources in developing countries.

Implications for Practice

Empirical results provide some useful policy and administrative implications for policymakers and administrators in the local government arena. Municipal officials should first shift their focus from normal administrative work to actively exploring new innovations in services to bring about sustainable development. Rather than a luxury, innovation needs to be seen as a critical life skill and a means to the benefit of society. The circular economy offers an intermediate link and service delivery models should be intentionally designed with a strong emphasis on material recovery and resource efficiency (e.g., shared resource networks, digital waste tracking systems). By implementing these circular structures, practitioners can leverage their creativity and ingenuity to realize tangible sustainability achievements, connecting the dots between process changes and broader SDG ambitions.

Secondly, it provides a strong impetus to the municipalities, especially in developing countries like Malaysia, to address problems arising from limited resources. The administrators need to advocate for increased funding for network skills and technology. Otherwise, they will be severely limited in their ability to effectively use service innovation. In addition, those who are tasked with running public sector organizations need to take a broad view of performance measurement, using social and environmental measures as well as measures of pure economic efficiency. Lastly, the moderating role of stakeholder and regulatory pressures enables municipal leaders to make smart decisions about their innovative services and how they can meet public needs and legal requirements. This alignment is important in order to gain long-term community support and institutional acceptance.

Conclusion

To meet the United Nations Sustainable Development Goals (SDGs), there is a need to transform existing public administrative processes in a structural way, going beyond the linear approach. The research addresses a key research need in institutional and innovation studies by offering a map of the empirical links between open and closed service innovations and multidimensional outcomes of sustainability in local government systems. This study seeks to draw on empirical data from the municipalities to verify that both closed and open service innovation models are important structural enablers that contribute to the achievement of economic and social sustainability goals. A crucial implication for environmental protection, however, is that closed configurations of innovation are not seen to provide statistically significant impact on the environment, while open innovation mechanisms have a broader impact on all three aspects of sustainable development. Importantly, in this empirical study, the architecture of the circular economy is confirmed as a necessary partial intermediary. The service innovations have to be strategic in order to create public value, but also have to be functional and integrate into the resource-loop practices, in order to operationalize the macro-level SDG targets. Remarkably, the effectiveness of these pathways from innovations to circularity is very local. One key finding in this investigation is that pressure from external stakeholders acts as an "operational amplifier" that greatly enhances the relationship of collaborative, open service innovation streams and circular economy adoption. On the contrary, there is no statistically significant moderating effect within this municipal structure with top-down regulatory demands. This means that merely legislating for compliance is not enough to move towards genuine substantive circular transition in resource-constrained public sectors, and it is more a matter of local, normative expectations from stakeholders that can trigger genuine and meaningful organizational transformation.

Policy Suggestions

The lack of statistical significance of regulatory pressure is an important indicator of significant structural weaknesses in the traditional command and control governance in an emerging municipality. Strict compliance with circular laws is often not achieved or is purely symbolic, as public sector administration structures often do not have the financial liquid resources, audit networks, or technological infrastructure to enforce or implement strict circular laws. To maximize this, the policymaker needs to shift from a coercive legal approach to a more enabling approach within the administrative sphere. The punishment for non-compliance should be replaced by targeted capacity-building programs and strong institutional incentives from higher levels of government. This involves setting up special municipal funding for green infrastructure, creating technology transfer schemes, and developing regional performance awards for genuine circular service delivery. In addition, the only effective moderator previously identified was stakeholder pressure, so policies should take a stand to make public information democratic. Policymakers can support citizen networks to co-design and maintain public circular systems through community feedback platforms and participatory urban planning dashboards.

Limitations and Future Research Direction

This investigation not only contributes to practice and theory but also has a number of limitations that suggest new avenues for research. First of all, the results on the effects of SI for sustainable development in local government are heavily dependent on cross-sectional results. The relationship between sustainable outcomes and service innovation warrants the use of longitudinal studies over a longer timeframe in future studies, especially for municipalities dealing with changing environmental regulations. Further research could also explore further aspects of sustainability to create a richer understanding of the role of public service delivery in sustaining society over time. Although this paper confirms the circular economy as a vital mediator, future scholars need to test these interactions across a variety of institutional environments. The sway of stakeholder and regulatory pressures could fluctuate dramatically across different tiers of government or global regions. For example, future studies might look into how varying degrees of digital sophistication or political decentralisation impact a local authority's ability to roll out CE practices. Finally, examining the influence of leadership styles and organisational culture on the promotion of service innovation fell outside the remit of this current project. It is highly recommended that future research models incorporate these internal behavioural elements to offer a completely holistic understanding of the forces driving sustainable development within the public sector.

FUNDING: This research was funded by the Fundamental Research Grant Scheme (FRGS) under grant number No. So Code21570. The content of this paper is solely the responsibility of the authors and does not necessarily represent the official views of the Ministry of Education, Malaysia.

INSTITUTIONAL REVIEW BOARD STATEMENT: This study was approved by the School of Technology Management and Logistics, Universiti Utara Malaysia, Malaysia under protocol number [UUM/STML/P-19]. Informed verbal consent was obtained from all participants and all data were anonymized to protect participants' confidentiality.

TRANSPARENCY: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

COMPETING INTERESTS: The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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