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Public-private partnerships as catalysts for digital transformation and circular economy: Insights from developing countries☆

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ABSTRACT

This study investigates the dynamics of Public-Private Partnerships (PPPs) in promoting digital transformation and circular economy initiatives in the public sector of developing countries. Using Collaborative Advantage Theory (CAT) and a multiple-case study design, involving 10 public and 12 private organizations across five cases, the research explores how complementary resources, collaborative processes, trust and governance, and mutual benefits and value creation shape the success of these partnerships. Data were collected through 50 semi-structured interviews with key stakeholders and archival analysis of partnership agreements, project reports, and policy documents. The findings reveal that strategic alignment and collaborative leadership are key triggers for synergy creation and co-creation of value. Additionally, participatory governance models and transparent performance metrics enhance trust and sustainability within PPPs. These results offer important theoretical contributions by expanding Collaborative Advantage Theory in the context of PPPs, emphasizing how collaboration and resource integration lead to sustainable outcomes. Practically, the study provides recommendations for policymakers and private sector leaders to improve the governance, resilience, and scalability of PPPs, promoting long-term public service innovation and sustainability.

1. Introduction

Public-private partnerships (PPPs) have emerged as a critical mechanism for addressing the multifaceted challenges faced by developing countries, particularly in facilitating both digital transformation and circular economy initiatives (Okpalaoka, 2023; Esposito and Dicorato, 2020). These nations frequently contend with constrained financial resources, technological deficiencies, and environmental vulnerabilities that impede the effective delivery of public services. While digital transformation focuses on the integration of digital technologies to enhance public sector efficiency, transparency, and responsiveness, circular economy initiatives aim to restructure resource flows towards reuse, regeneration, and sustainability (Verweij and Satheesh, 2023; Sheng et al., 2020). Although conceptually distinct, these two paradigms increasingly intersect, as digital technologies enable smarter resource management, improve traceability, and support the implementation of circular practices (Ishaq et al., 2024). In this context, PPPs serve as platforms where digital innovation and sustainability objectives converge, offering a pathway to simultaneously modernize public services and foster sustainable development. While prior research acknowledges the role of PPPs in bridging resource gaps and fostering innovation (Balsalobre-Lorente et al., 2024; Mazzucato and Robinson, 2018), there remains a lack of theoretical clarity on how these collaborations function as catalysts for resilience and sustainability in the public sector. Existing studies often focus on the policy frameworks or economic benefits of PPPs but do not sufficiently examine the underlying mechanisms that enable these partnerships to succeed in resource-limited settings.

Another key gap in the literature lies in the limited understanding of how PPPs contribute to the resilience of public sector services—the capacity to maintain core functions, recover from crises, and adapt to evolving conditions (Tanveer et al., 2024). Although digital transformation and circular economy models are recognized as critical pathways towards sustainability, prior studies have insufficiently

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examined the relational and structural mechanisms that enable public-private collaborations to overcome institutional barriers and technological integration challenges (Campmas et al., 2022; Gumbo and Moyo, 2020). In particular, the interoperability between public and private entities—the seamless exchange of data, knowledge, and technological capabilities—has emerged as a crucial enabler of sustainable digital transitions. Anchored within the framework of Collaborative Advantage Theory (CAT), interoperability reflects the processes of resource integration and joint value creation that are essential for achieving collaborative advantage and enhancing partnership resilience. However, empirical research on how interoperability is built, maintained, and leveraged within PPPs, especially in the context of developing countries, remains scarce.

Moreover, while prior research acknowledges the importance of collaboration between public and private actors, there is limited theoretical engagement with how these partnerships generate long-term value and sustain innovation in contexts marked by regulatory uncertainties and resource constraints (Haug et al., 2024; Scupola and Mergel, 2022). Collaborative Advantage Theory (CAT) offers a relevant yet underutilized lens for addressing this gap, as it provides insights into how complementary resources, trust, governance structures, and mutual value creation contribute to the success of collaborative arrangements (Huxham and Vangen, 2000). However, despite its applicability, CAT has not been systematically applied to the study of PPPs in digital transformation and circular economy initiatives in developing countries.

This study responds to these gaps by examining the dynamics of PPPs through the lens of CAT, with a particular emphasis on how these partnerships enhance resilience and sustainability through interoperability and collaborative processes. By doing so, it provides a deeper understanding of the mechanisms that enable PPPs to function effectively in resource-constrained environments. This focus directly informs the study's research aim, which is to explore the role of PPPs in digital transformation and circular economy initiatives within the public sector of developing countries. Specifically, the study seeks to understand how these partnerships contribute to public sector resilience and the role of interoperability in shaping their success. Considering this aim, the research question guiding this study is:

Research question: How do public-private partnerships foster the integration of digital transformation and circular economy principles, and how does their interoperability enhance the resilience and sustainability of public sector services in developing countries?

This study is grounded in Collaborative Advantage Theory (CAT) to explore how PPPs facilitate digital transformation and circular economy initiatives within the public sector. CAT is well-suited for this research as it explains how organizations achieve mutual benefits through collaboration, emphasizing resource integration, trust, and governance (Huxham and Vangen, 2000). Given the institutional and resource constraints in developing countries, CAT provides a valuable lens to examine how PPPs leverage complementary strengths to enhance resilience and interoperability. Unlike traditional partnership theories, CAT focuses on sustained collaboration rather than transactional exchanges, making it particularly relevant for complex, long-term initiatives. The research adopts a qualitative approach, employing a multiple case study design (Yin, 2017) to investigate five PPP cases focused on digital technologies and sustainable circular economy practices in the context of developing countries. These partnerships involve 10 public sector entities and 12 private sector organizations, which collectively contribute to digital infrastructure, green technologies, and sustainability efforts. The study's design enables an in-depth exploration of how these PPPs address the unique challenges of technology adoption and environmental sustainability in developing countries. To gather rich and contextualized data, 50 key informants are interviewed, including 2 to 3 key participants from each organization. These participants, comprising managers and experts directly engaged in the partnerships, provide detailed insights into the processes, strategies, and outcomes of the collaborations. The interviews serve as a critical tool for understanding the mechanisms that drive the successful integration of digital transformation and circular economy initiatives within public sector services, contributing to resilience and sustainability in developing countries. Accordingly, this study contributes to advancing the understanding of how PPPs, through the lens of Collaborative Advantage Theory, can support the integration of digital transformation and circular economy initiatives in developing countries, emphasizing the relational mechanisms that enable resilience and sustainability.

This manuscript is divided into six main sections to thoroughly explore the research topic. Section 2 introduces the theoretical framework, laying the groundwork for the study's conceptual approach. Section 3 outlines the qualitative research methodology, including the multiple case study design, sampling techniques, and data collection strategies employed to gather in-depth, contextual data. Section 4 presents the empirical findings, summarizing the key insights derived from the case studies. Section 5 offers a detailed discussion of these findings, relating them to existing literature and theoretical perspectives. Finally, Section 6 wraps up the manuscript by highlighting the study's theoretical contributions, discussing its practical implications, acknowledging research limitations, and proposing potential avenues for future research.

2. Theoretical background

2.1. The necessity of digital transformation and circular economy adoption in developing countries

In developing countries, the need for digital transformation and the adoption of circular economy principles has become increasingly urgent as these nations face significant environmental, economic, and social challenges (Ishaq et al., 2024). Digital transformation, encompassing the integration of technologies such as Internet of Things (IoT), data analytics, and smart infrastructure, is increasingly seen as a key driver of progress in public sector services. These technologies can modernize outdated infrastructure, improve service delivery, and enhance the responsiveness of public systems to the dynamic needs of the population (Scupola and Mergel, 2022; Laplane and Mazzucato, 2020). By leveraging these innovations, developing countries can overcome some of the most pressing challenges they face, such as inefficient public service delivery, limited access to resources, and a lack of technological capacity. Through the integration of data-driven decision-making, automated systems, and smart city technologies, public services can be optimized to provide more efficient, accessible, and equitable outcomes for citizens (Tanveer et al., 2024; Cordova and Stanley, 2021).

Furthermore, the concept of the circular economy has gained traction as an essential model for achieving sustainability in resource-limited contexts. The circular economy focuses on creating a closed-loop system where resources are continually reused, waste is minimized, and environmental impact is reduced (Balsalobre-Lorente et al., 2024). This model contrasts with the traditional linear economic model, which often results in wasteful consumption and unsustainable resource extraction. By shifting towards circularity, developing countries can reduce their reliance on finite resources, enhance recycling and reuse practices, and promote eco-friendly infrastructure, all of which are crucial for long-term environmental sustainability (Ishaq et al., 2024; Khan et al., 2020). The circular economy also creates opportunities for job creation, especially in sectors such as waste management, renewable energy, and sustainable manufacturing, which can drive economic growth while promoting social responsibility and environmental preservation.

The integration of digital transformation and circular economy principles is essential not only for economic growth but also for ensuring the resilience of public sector systems in developing countries (Horák and Špaček, 2024; Panda, 2016). These two concepts are inherently interconnected, as digital technologies serve as enablers for circular economy initiatives, optimizing resource efficiency and enhancing

sustainability efforts. Digital transformation facilitates circular economy adoption by improving waste tracking, enabling predictive maintenance in manufacturing, and enhancing resource-sharing models through data-driven platforms (Hoang and Bui, 2023). Technologies such as the Internet of Things (IoT), artificial intelligence (AI), and blockchain support circularity by increasing transparency in supply chains, enabling real-time monitoring of material flows, and reducing inefficiencies in waste management systems. Simultaneously, circular economy principles reinforce the goals of digital transformation by promoting long-term sustainability and systemic efficiency, ensuring that digital advancements contribute to reducing environmental impact rather than exacerbating resource depletion (Rybnicek et al., 2020; Joglekar et al., 2022).

By embracing both digital and circular approaches, governments can enhance their capacity to monitor and manage resources more effectively, leading to better disaster preparedness, risk mitigation, and recovery strategies. The circular economy provides a pathway to reducing vulnerability to supply chain disruptions by fostering sustainable, locally sourced, and resilient systems, while digital transformation ensures the efficiency and scalability of these efforts through automation, data analytics, and digital governance (Rybnicek et al., 2020; Joglekar et al., 2022). Together, these two frameworks reinforce each other, forming the foundation for sustainable development by addressing interconnected environmental, social, and economic challenges. This synergy also contributes to public sector governance reform, allowing governments to leverage digital tools to enforce circular economy policies more effectively and improve cross-sector collaboration.

Despite their mutual benefits, implementing both digital transformation and circular economy models in developing countries presents significant challenges (Shen et al., 2023; Joglekar et al., 2022). One of the primary difficulties is the resource constraints faced by governments, which often lack the financial and technical capacity to invest in large-scale digital and sustainability initiatives. Public sector organizations in developing countries frequently struggle with outdated infrastructure, limited digital literacy, and fragmented policy implementation (Laplane and Mazzucato, 2020; Verweij and Satheesh, 2023). Additionally, institutional rigidities—such as bureaucratic inefficiencies, regulatory misalignment, and resistance to change—further hinder integration efforts (Cordova and Stanley, 2021). The lack of coordination between public policies and private sector innovation exacerbates these challenges, creating barriers to the seamless implementation of digital tools that could otherwise accelerate circular economy transitions. Addressing these issues requires targeted governance reforms and strategic partnerships, ensuring that both digital transformation and circular economy initiatives are mutually reinforcing rather than operating in isolation.

2.2. Public-private partnerships (PPPs) as a support mechanism for digital transformation and circular economy initiatives

Public-private partnerships (PPPs) are collaborative agreements between public and private entities, designed to leverage the strengths and resources of both sectors to achieve mutual goals (Marana et al., 2020; Haug et al., 2024). In these partnerships, the public sector typically provides regulatory frameworks, policy support, and infrastructure, while the private sector brings innovation, technical expertise, and financial resources. PPPs have become an increasingly popular mechanism for addressing complex societal challenges, particularly in developing countries where resource constraints and institutional limitations often hinder progress. These partnerships offer several advantages, such as shared risk, enhanced efficiency, and the ability to scale innovative solutions across a range of sectors, including digital transformation and circular economy initiatives (Verweij and Satheesh, 2023; Kirikkaleli and Adebayo, 2021). By pooling resources and expertise, PPPs can enable the successful implementation of large-scale projects that would otherwise be beyond the reach of public or private entities acting alone.

The role of PPPs in supporting digital transformation and circular economy initiatives in developing countries is especially critical. Digital transformation demands significant investment in technologies and infrastructure, areas where the private sector often excels but where the public sector lacks the capacity or financial resources to drive change independently (Aben et al., 2021; Sheng et al., 2020). Similarly, the circular economy necessitates shifts in infrastructure, policies, and behaviors, all of which require coordinated efforts from both sectors. PPPs serve as a strategic mechanism to bridge the gap between the financial and technical capabilities of the private sector and the regulatory and policy frameworks of the public sector (Laplane and Mazzucato, 2020). By facilitating the integration of private sector innovations—such as IoT, big data, cloud computing, and sustainable infrastructure—with the public sector's need for scalable and sustainable solutions, PPPs can effectively drive the adoption of digital and circular economy models. These collaborations allow the public sector to benefit from cutting-edge technology while ensuring that solutions are aligned with public policies aimed at sustainability, social equity, and long-term development goals (Marana et al., 2020; Esposito and Dicorato, 2020).

Interoperability within PPPs plays a crucial role in the successful implementation of digital transformation and circular economy initiatives (Gumbo and Moyo, 2020). For PPPs to be effective, public and private entities must be able to work seamlessly together, sharing data, technologies, and processes that enable the smooth functioning of collaborative projects. The importance of interoperability lies in its ability to synchronize the goals and actions of both sectors, ensuring that innovations are deployed in a way that aligns with regulatory frameworks, policy priorities, and societal needs. When interoperability is achieved, it contributes to greater efficiency, innovation, and scalability of projects, as public sector institutions can leverage private sector expertise without facing barriers due to technological incompatibilities or administrative delays (Pliatsios et al., 2023). This synergy enhances the overall effectiveness of digital transformation and circular economy projects, ensuring that resources are utilized optimally and that outcomes are achieved in a timely manner.

Moreover, PPPs play a significant role in enhancing resilience within public sector services. Resilience, in this context, refers to the ability of public sector systems to adapt, recover, and continue providing essential services in the face of disruptions such as economic crises, natural disasters, or technological shifts (Shen et al., 2023; Horák and Špaček, 2024). By fostering collaboration between the public and private sectors, PPPs help build adaptive capacities within public institutions. The private sector's agility and innovation capabilities, combined with the public sector's long-term vision and regulatory oversight, allow for the development of flexible, scalable solutions that can respond to dynamic challenges. Through these partnerships, public sector services can become more robust, ensuring continuity even in times of crisis. The resilience fostered by PPPs is not only critical for maintaining public services during disruptions but also for enabling the long-term sustainability of digital transformation and circular economy initiatives, ensuring they remain effective and relevant as the challenges facing developing countries evolve (Shen et al., 2023).

2.3. Collaborative advantage theory (CAT) and its application to interoperability and resilience in PPPs

Collaborative Advantage Theory (CAT) provides a robust framework for understanding the dynamics of public-private partnerships (PPPs) by emphasizing how collaboration between public and private sectors generates mutual benefits. CAT, introduced by Huxham and Vangen (2000), focuses on resource integration, collaborative processes, and mutual value creation, making it particularly relevant for PPPs involved in digital transformation and circular economy initiatives (Zhao et al., 2018; Huxham, 1997). While CAT has been widely applied in sectors such as healthcare, education, and environmental sustainability, its application to PPPs in developing countries—where resource constraints

and institutional challenges are pronounced—remains underexplored (Hansen and Nohria, 2004; Verweij and Satheesh, 2023).

Alternative theoretical perspectives, such as Resource Dependency Theory (RDT) and Institutional Theory, provide useful but limited explanations for the dynamics of PPPs in this context. RDT (Pfeffer and Salancik, 1978) highlights how organizations form partnerships to reduce uncertainty and secure critical resources, framing PPPs primarily as transactional arrangements driven by external dependencies. While RDT explains why public and private actors engage in partnerships, it does not sufficiently address the internal collaborative processes—such as trust-building, governance, and mutual adaptation—that are critical to long-term partnership success, particularly in uncertain environments. Similarly, Institutional Theory (DiMaggio and Powell, 1983) examines how organizations conform to regulatory and normative pressures, offering insights into the broader institutional environment shaping PPPs. However, it lacks a strong focus on how collaboration actively generates value, especially in contexts requiring innovation and adaptability. Although CAT provides a valuable lens by shifting attention to the mechanisms of collaboration and co-creation, it also carries limitations. CAT tends to assume that collaborative advantage is achievable through deliberate alignment of interests and processes, which may underestimate the persistence of power asymmetries and external institutional pressures in complex PPP environments, particularly in developing countries. Nonetheless, CAT remains well-suited for this study as it offers a dynamic perspective to explore how PPPs build resilience and interoperability, while acknowledging that collaboration outcomes are often shaped by broader contextual constraints.

CAT is better suited for this study because it moves beyond dependency and institutional conformity to explain how organizations leverage complementary strengths to drive innovation and sustainability in PPPs. Unlike RDT, which focuses on resource scarcity, or Institutional Theory, which emphasizes structural constraints, CAT provides a more dynamic perspective by analyzing how public and private actors integrate their resources, align strategic goals, and establish governance structures that enhance resilience and interoperability. Given that PPPs in developing countries face challenges requiring continuous adaptation and long-term collaboration, CAT offers the most appropriate framework to examine how these partnerships generate sustainable public service outcomes.

The role of collaborative processes in PPPs is another key element of CAT that contributes to our understanding of how these partnerships function effectively. Shared decision-making, joint leadership, and coordinated efforts between public and private partners enable the creation of innovative solutions that neither sector could achieve independently (Zhao et al., 2018; Khan et al., 2020). In the context of digital transformation and circular economy projects, collaborative processes allow both sectors to align their goals and actions, resulting in more efficient resource allocation, improved project execution, and the ability to scale solutions. Joint leadership fosters a sense of shared ownership and accountability, ensuring that both parties are equally invested in the long-term success of the initiative (Khan et al., 2020; Laplane and Mazzucato, 2020). Through these processes, the private sector's agility and innovation can be paired with the public sector's regulatory oversight and long-term vision, creating a governance structure that facilitates collaboration and mutual benefit.

Central to the success of PPPs is the establishment of trust and transparent governance models, which are foundational elements in CAT. Trust between public and private sector actors ensures that both parties are committed to the partnership's goals and will fulfill their respective responsibilities (Verweij and Satheesh, 2023; Aben et al., 2021). Transparent governance structures provide clarity on roles, responsibilities, and performance expectations, which in turn foster collaboration and accountability. The theory posits that when trust is built and maintained, and when clear governance frameworks are established, partnerships are more likely to succeed in both the short and long term. This is particularly important in resilient collaborations, where the ability to adapt to crises and challenges requires that both public and private actors trust each other and work together seamlessly (Cordova and Stanley, 2021; Marana et al., 2020). Transparent performance metrics, including financial and social impact indicators, further solidify this trust by ensuring that both sectors are held accountable for their contributions and that project outcomes are aligned with societal needs.

Finally, CAT highlights the creation of mutual benefits and value creation as a crucial outcome of effective PPPs. The theory asserts that partnerships are most successful when both sectors benefit, whether through financial returns for the private sector or improved public services and societal outcomes for the public sector. The concept of value creation in CAT goes beyond simple profit generation; it includes the social, environmental, and economic benefits that arise from aligning long-term public welfare goals with private sector objectives (Marana et al., 2020; Haug et al., 2024). In the case of digital transformation and circular economy initiatives, PPPs can generate value by improving public service delivery, enhancing environmental sustainability, and driving economic growth. By aligning the private sector's market-driven goals with public sector priorities such as equity, sustainability, and social welfare, PPPs can create solutions that are not only innovative and efficient but also socially responsible and inclusive.

3. Methodology

3.1. Research design

This study employs a multiple-case research design (Yin, 2017) to examine the dynamics of Public-Private Partnerships (PPPs) in driving digital transformation and circular economy initiatives in developing countries. A multiple-case approach enables a comparative analysis of partnership dynamics across different contexts, providing a nuanced understanding of how PPPs integrate resources, establish governance structures, and sustain long-term collaboration. Grounded in Collaborative Advantage Theory (CAT), the study explores how these partnerships enhance resilience, interoperability, and value creation to foster public service innovation and sustainability.

The selection of cases was guided by specific criteria to ensure methodological rigor and relevance to the study's objectives. The primary criterion was sectoral relevance, as the cases were chosen based on their engagement in digital transformation and circular economy initiatives. The selected PPPs operate in key areas such as urban infrastructure, sustainability programs, and digital capacity-building within the public sector. This ensures that the study captures diverse applications of PPP models in facilitating technological innovation and environmental sustainability. Additionally, the maturity of the partnerships was considered, with cases including both well-established collaborations and emerging partnerships. This variation allows for an examination of both the initial formation of PPPs and the long-term mechanisms that sustain these partnerships over time. The study also accounts for regional diversity, selecting cases from multiple developing countries to capture variations in institutional, economic, and regulatory environments. This approach enhances the study's ability to identify both context-specific challenges and broader patterns in PPP implementation.

The research process began with an exploration of the broader shifts in PPP models within developing countries, particularly since the 2010s, focusing on how these partnerships have evolved to address challenges related to digital transformation and sustainability. This contextual analysis provided critical insights into the structural and functional transformations of PPPs, helping to refine the study's focus on the key factors influencing the success or failure of such collaborations. Data collection involved a combination of primary and secondary sources. Semi-structured interviews were conducted with managers and experts directly involved in the partnerships, providing rich, qualitative insights into their operational dynamics. These interviews were complemented by an extensive review of archival documents, including industry

reports, policy frameworks, and organizational agreements, ensuring a comprehensive understanding of the institutional and strategic context in which these PPPs operate.

The study adopts a process perspective of sensemaking (Weick, 1995; Langley and Tsoukas, 2010) to examine how actors within PPPs interpret and navigate collaboration in dynamic and uncertain environments. Unlike traditional variance-based models that emphasize static relationships, a sensemaking approach allows for an exploration of how PPP stakeholders continuously adapt their strategies, align their objectives, and respond to emerging challenges. This theoretical perspective aligns with the CAT framework, reinforcing the study's focus on how collaborative processes, resource integration, and governance structures shape the effectiveness of PPPs.

By integrating theoretical insights with empirical data, this study enhances both the depth and practical relevance of its conclusions. The multiple-case design allows for a systematic comparison of partnership models, facilitating the identification of recurring patterns and the emergence of theoretical insights applicable to PPPs in different contexts. The comparative nature of this research strengthens its ability to account for variations across public and private sector collaborations, offering a robust framework for understanding the conditions under which PPPs can drive sustainable and technology-enabled development. The findings are expected to contribute to both academic literature and policy discussions, providing actionable insights into the governance, scalability, and long-term viability of PPPs in developing economies. Tables 1 and 2 present detailed information on the selected partnerships and the participants involved in the study.

3.2. Data collection

Data collection for this study involved a multi-method approach, combining in-depth interviews with archival document analysis to gain a well-rounded understanding of the dynamics within public-private partnerships (PPPs). A key focus was placed on engaging senior leaders and managers from both public and private sectors, as their decision-making and strategic roles are crucial in shaping the success and direction of PPP projects. To expand the range of insights, a snowball sampling was chosen to identify key informants with direct

Table 1
Partnership case details.

Partnership cases	Partnership overview	Partnership time	Roles and contributions	Outcomes and impact
Partnership Case A - Smart City Solutions	This partnership aims to enhance urban resilience and sustainability by integrating digital technologies into city infrastructure and governance. The collaboration was motivated by the need to improve public services, optimize resource management, and address environmental challenges through smart solutions.	Initiated in 2016 and currently ongoing.	- Public Sector: Provided regulatory frameworks, urban infrastructure, and policy guidance to ensure the project met sustainability and public interest goals. - Private Sector: Led the technological development and deployment of smart systems (e.g., smart lighting, intelligent transportation), contributing capital investment, expertise, and innovative solutions.	The project improved energy efficiency by 15 % and reduced carbon emissions by 12 % through the implementation of smart grids and digital waste management systems. Traffic congestion was reduced by 20 %, and public satisfaction with municipal services increased by 25 %. The ongoing collaboration has built long-term urban resilience, ensuring sustainability despite environmental and economic shocks.
Partnership Case B - Green Infrastructure	This collaboration seeks to drive the transition to a circular economy by financing and developing green infrastructure projects that promote sustainable resource management and environmental protection. The partnership was formed to address the need for climate resilience and improve the sustainability of urban spaces.	Launched in 2019, ongoing.	- Public Sector: Facilitated policy frameworks, incentives, and land access for the development of green infrastructure projects, ensuring regulatory compliance. - Private Sector: Contributed financial capital and expertise in implementing green building technologies, such as solar panels, green roofs, and waste-to-energy systems.	The initiative has led to the development of over 50 green buildings, improving urban biodiversity by 31 %. Additionally, it has contributed to a 23 % reduction in waste through the implementation of circular waste management systems. The project is also driving job creation in the green sector, with an estimated 500 jobs created in construction and technology sectors.
Partnership Case C - Digital Transformation Training	This partnership was established to enhance the digital capabilities of public sector employees, enabling them to adopt and implement digital transformation initiatives in government services. The motivation behind this collaboration was to build public sector resilience through digital literacy and improve service delivery.	Began in 2021, ongoing.	- Public Sector: Coordinated with private partners to identify training needs, ensure employee access, and align programs with government priorities in e-governance and cybersecurity. - Private Sector: Developed and delivered tailored training programs to public employees on topics such as data analytics, cloud computing, and digital tools for governance.	The program has successfully trained 62 % of public employees in digital tools, leading to a 31 % increase in efficiency in public service delivery. There was also a 17 % improvement in citizen satisfaction with government services. The training initiatives enhanced the digital readiness of the public sector to respond to emerging challenges such as cybersecurity and digital governance.
Partnership Case D - Data-Sharing Platforms	This collaboration was formed to develop data-sharing platforms that improve interoperability and resource management across sectors. By integrating data from both the public and private sectors, the partnership aimed to optimize urban planning, resource efficiency, and supply chain management.	Started in 2018, ongoing.	- Public Sector: Established data privacy regulations, provided data access from public infrastructure systems, and set policy guidelines. - Private Sector: Developed the data-sharing platform, provided technology infrastructure, and ensured data analytics and integration across sectors.	The platform facilitated real-time data sharing that improved resource management and efficiency in urban services like waste management and traffic monitoring. The platform also helped reduce operational costs by 15 % and improved supply chain transparency in municipal services. The initiative enhanced public-private collaboration, promoting data-driven decision-making in governance.
Partnership Case E - Medical Waste Management	The partnership between public health agencies and private waste management companies aimed to develop sustainable solutions for medical waste disposal. The collaboration was motivated by the need to ensure safe disposal and environmental protection in managing hazardous medical waste.	Initiated in 2017, ongoing.	- Public Sector: Developed regulatory standards, monitored compliance, and ensured public health safety. - Private Sector: Managed the collection, treatment, and disposal of medical waste, providing innovative technologies for waste management.	The partnership led to safe disposal of over 500 tons of medical waste annually. It improved health outcomes by reducing environmental contamination and public health risks. The project also promoted recycling initiatives, which diverted 28 % of medical waste from landfills and generated sustainable waste-to-energy solutions.

Table 2
Participating entities in each partnership case.

Partnership cases	Entity code	Sector	Size (approximately employees)	Established year	Entity context/ nature/ specification
Partnership Case A - Smart City Solutions	A1	Public	1500	1976	Local Government Authority - Manages public services and urban development, overseeing municipal infrastructure and city planning activities.
	A2	Public	900	1978	Urban Planning Department - Focuses on city planning, regulatory compliance, and developing policies for sustainable urban growth.
	A3	Private	700	1991	A corporation specializing in IoT solutions, data analytics, and smart city infrastructure.
	A4	Private	400	1997	A corporation focuses on developing and implementing clean energy solutions, including solar power systems and energy-efficient infrastructure in urban areas.
Partnership Case B - Green Infrastructure	B1	Public	1800	1978	Government Agency - Regulatory body responsible for environmental protection, waste management, and sustainability policies.
	B2	Public	1500	1981	Regional Sustainability Department - Implements national sustainability frameworks, focusing on eco-friendly urban infrastructure, green policies, and climate adaptation strategies.
	B3	Private	500	1995	A financing corporation focuses on financing sustainable infrastructure projects, investing in green technologies and eco-friendly solutions.
	B4	Private	500	2009	A fund that provides funding for sustainable infrastructure projects with an emphasis on green technologies and circular economy ventures.
	B5	Private	600	1994	A leading technology corporation specializes in the development of renewable energy systems, green building technologies, and sustainable construction.
Partnership Case C - Digital Transformation Training	C1	Public	800	1999	Ministry of Digital Affair - Oversees national digital transformation, e-governance, and public sector IT adoption strategies.
	C2	Public	800	2003	Public Service Commission - Focuses on the digital skill development of public servants and training programs for government employees.
	C3	Private	400	2009	A consultant firm provides consulting and training services to governments on digital transformation strategies, cloud computing, and data management systems.
	C4	Private	250	2011	A research and training institution provides tailored digital skills training programs, with a focus on government workforce technology adoption.
Partnership Case D - Data-Sharing Platforms	D1	Public	900	1997	National Data Authority - Governs the national data infrastructure, ensuring data privacy, security, and access policies for public services.
	D2	Public	1100	1980	Urban Planning Ministry- Develops national urban planning policies, infrastructure development, and oversees data integration for smart cities.
	D3	Private	150	2011	A firm that provides data management services, cloud platforms, and big data solutions to support data sharing and interoperability across sectors.
	D4	Private	600	2007	A technology firm specializes in data management, cloud computing, and creating interoperable data platforms for public-private use.
Partnership Case E - Medical Waste Management	E1	Public	2000	1975	Department of Health - Develops regional health policies, manages public health programs, and ensures safe medical waste disposal regulations.
	E2	Public	1100	1979	Environmental Health Agency - Implements policies for environmental health safety, focusing on waste management and hazardous materials.
	E3	Private	500	2013	A corporation specializes in medical waste disposal, hazardous material management, and sustainable waste treatment solutions for healthcare institutions.
	E4	Private	700	2012	A corporation provides eco-friendly waste management services, focusing on biomedical waste, recycling, and waste-to-energy technologies.
	E5	Private	500	2015	A corporation that develops innovative waste treatment technologies, including medical waste incineration and sterilization to ensure environmental compliance.

involvement in PPP initiatives, ensuring access to relevant expertise across public and private sectors. To mitigate potential bias and achieve balanced representation, initial participants were selected from diverse organizational levels and functions, and referrals were cross validated to include a mix of perspectives, including policymakers, project managers, and technical experts. A total of 50 semi-structured interviews were conducted with stakeholders from both public entities and private organizations, including senior executives, project managers, and key decision-makers. These interviews took place over the period from May 2023 to October 2024. The semi-structured format was chosen for its flexibility, allowing the researcher to probe emerging themes and adjust questions based on the responses (Harley and Cornelissen, 2022), while still maintaining focus on core topics such as interoperability, resilience, and collaborative dynamics in PPPs. This approach enabled an in-depth exploration of the contextual factors that shape these partnerships, providing nuanced insights into how public and private sectors collaborate to drive digital transformation and circular economy initiatives.

Alongside the interviews, archival documents—such as partnership agreements, project reports, policy documents, and industry publications—were collected and analyzed. These documents provided essential background information and contextual insights, enriching the understanding of the formal and informal structures within each case study. Data saturation was assessed through an iterative process, where interviews continued until no new themes or insights emerged, ensuring comprehensive coverage of stakeholder perspectives. Thematic saturation was identified when responses from new participants consistently reinforced previously established themes without introducing novel dimensions, indicating that additional data collection would yield diminishing returns. By triangulating data from interviews and archival sources, the study ensured a robust and well-rounded analysis of PPP dynamics, strengthening the reliability and completeness of the findings. Table 3 summarizes the interview details.

3.3. Data analysis

The data analysis for this study employed thematic analysis, an approach well-suited to identifying, interpreting, and synthesizing patterns within qualitative data (Gioia et al., 2013). The analysis process

Table 3
Interviewees' details.

No	Entity code	Interviewees titles	Experience (year)	Education	Interview time (minutes)
1	A1	Director of Urban Planning and Development	30	MA	80
2		Senior Urban Policy Advisor	21	BA	75
3	A2	Sustainability Policy Coordinator	25	MA	85
4		Senior Regulatory Compliance Officer	19	MA	70
5		Chief Technology Officer (CTO)	24	MA	90
6	A3	Director of Smart City Solutions	27	PhD	65
7		Head of Data Analytics and Integration	26	MA	75
8		Chief Sustainability Officer	19	MA	70
9	A4	Head of Renewable Energy Projects	24	MA	85
10		Director of Energy Solutions Implementation	26	PhD	90
11	B1	Senior Sustainability Officer	26	MA	85
12		Waste Management and Compliance Officer	28	BA	99
13	B2	Regional Sustainability Director	27	MA	85
14		Green Infrastructure Project Manager	25	MA	80
15	B3	Senior Investment Director, Green Infrastructure	21	MBA	90
16		Head of Sustainable Finance	26	MA	85
17		Fund Manager, Green Projects	24	MBA	65
18	B4	Director of Sustainable Infrastructure Investments	27	MBA	65
19		Senior Analyst, Circular Economy Investments	19	MA	70
20	B5	Manager of Green Building Solutions	17	MA	75
21		Director of Renewable Energy Systems	27	MA	75
22	C1	Director of *E*-Governance	23	MA	75
23		Head of Digital Transformation Strategy	26	MBA	80
24	C2	Senior Advisor on Digital Skills Development	19	BA	90
25		Training Program Coordinator	25	BA	70
26		Director of Cloud Computing Services	26	MA	75
27	C3	Senior Consultant, Digital Government Strategy	18	MA	80
28		Manager, Technology Adoption for Public Sector	24	MA	75
29	C4	Program Director, Digital Skills for Public Sector	28	PhD	65
30		Head of Training and Development	24	MA	60
31	D1	Director of Data Governance	26	MA	75
32		Senior Security and Compliance Officer	25	BA	80
33	D2	Smart Cities and Data Integration Specialist	17	MA	85
34		Senior Planner for Infrastructure Development	19	BA	80
35		Head of Data Services and Solutions	25	MA	90
36	D3	Senior Cloud Computing Architect	24	MA	86
37		Director of Data Sharing Initiatives	21	MA	90
38	D4	Director of Data Integration and Management	21	MA	80
39		Senior IT Solutions Architect	17	BA	65
40	E1	Director of Public Health Programs	26	MA	60
41		Head of Medical Waste Management Regulations	26	PhD	75
42	E2	Senior Waste Management Specialist	16	MA	60
43		Head of Hazardous Materials Compliance	23	PhD	65
44	E3	Operations Manager, Medical Waste Disposal	18	MA	75
45		Senior Health and Safety Officer	19	BA	80
46	E4	Director of Biomedical Waste Management	23	PhD	90
47		Senior Project Manager, Waste-to-Energy Solutions	17	BA	85
48		Chief Executive Officer	26	MA	75
49	E5	Director of Waste Treatment Technologies	27	MA	65
50		Senior Environmental Compliance Manager	18	MA	90

began with a thorough familiarization phase, where interview transcripts and archival documents were carefully reviewed to gain a deep understanding of the content and its contextual nuances. This step facilitated the development of preliminary insights and ensured that the analysis remained grounded in the empirical realities of the selected cases.

In the next step, the data underwent a systematic coding process, wherein significant segments were identified, categorized, and organized. The coding strategy integrated both inductive and deductive methods (Gioia et al., 2013; Yin, 2017). Inductive coding allowed the researcher to derive patterns directly from the data, capturing context-specific insights and partnership dynamics. In parallel, deductive coding was guided by the principles of CAT, ensuring that key themes—such as resource integration, collaborative process, governance and trust-building, and mutual value creation—were systematically analyzed in relation to the theoretical framework. This alignment between data and theory enabled the study to examine how PPPs facilitate collaboration, enhance resilience, and create long-term sustainability in digital transformation and circular economy initiatives. By integrating both empirical patterns and theoretical constructs, the analysis strengthened the study's conceptual grounding and contributed to a deeper understanding of PPP dynamics.

After coding, the relevant data segments were synthesized into overarching themes that captured key phenomena, such as the impact of digital technologies on inter-organizational collaboration and innovation. These themes were then analyzed to identify patterns and connections across the cases, offering a comparative view that highlighted both similarities and differences in the data. The analysis explored how these themes related to the research questions and the theoretical framework, shedding light on how relational dynamics influence the integration of digital technologies in the public-private partnership context.

The final stage of analysis involved interpretative synthesis, wherein the identified themes were connected to broader theoretical constructs such as knowledge and technology transfer, resource complementarity, and strategic alignment. This phase aimed to identify both facilitators and barriers to successful collaboration and innovation, providing a detailed understanding of the relational and technological factors

involved. To ensure the robustness and credibility of the findings, triangulation was employed, cross-verifying data from multiple sources. This method helped ensure analytical rigor and enhanced the validity of the results. This comprehensive and theoretically grounded analysis allowed for an in-depth exploration of how digital technologies influence the innovation capabilities of public-private partnerships, advancing both empirical knowledge and theoretical contributions to the field. Fig. 1 outlines the data structure.

4. Research findings

4.1. Complementary resources lead to synergy creation

In examining the complementary resources in PPPs, it becomes evident that the collaboration between public and private sectors fosters an environment where distinct capabilities from both sides contribute to achieving more effective and scalable outcomes. Across the five case

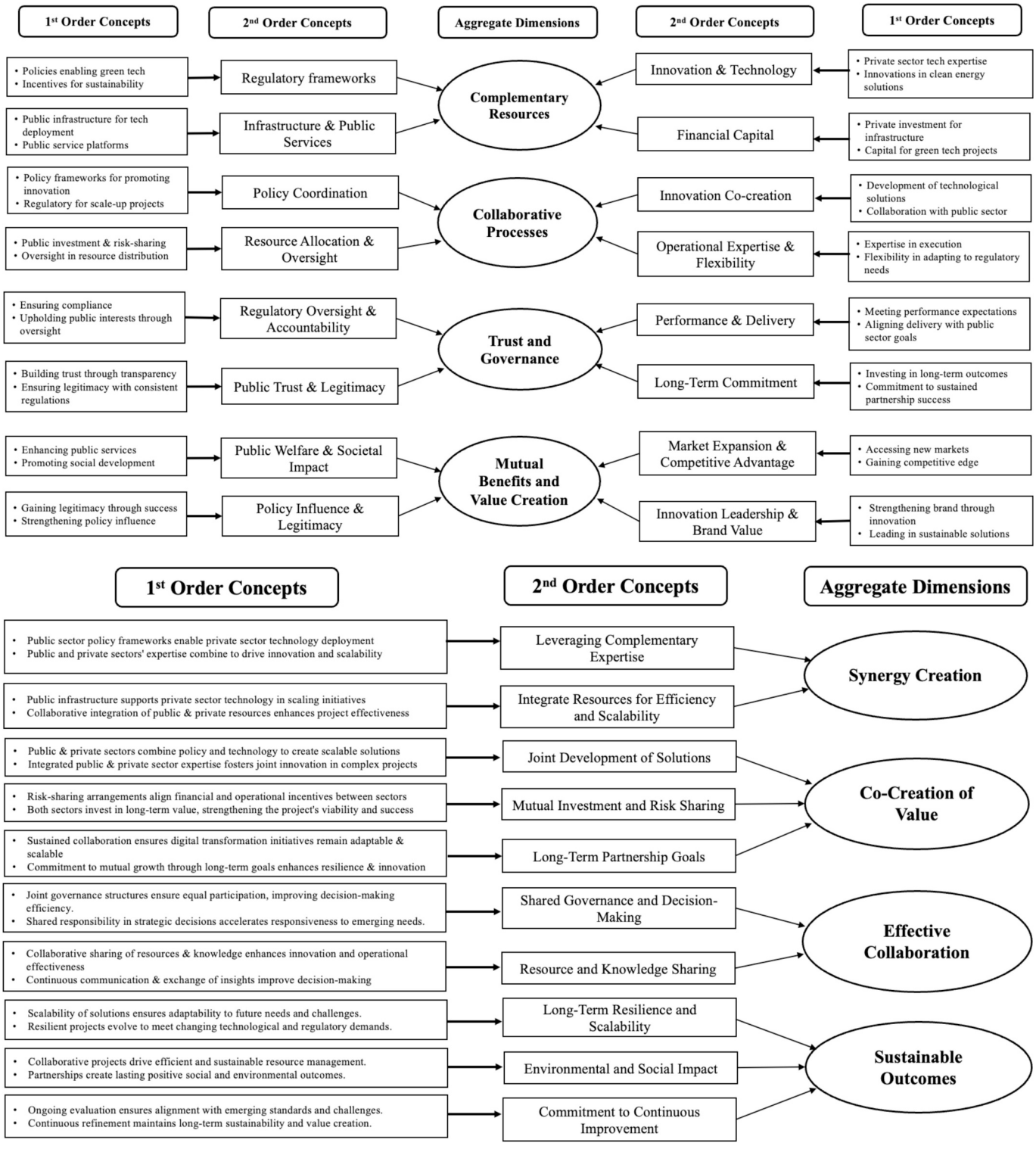

Fig. 1. Data structure.

partnerships, participants emphasized that the public sector's regulatory frameworks and infrastructure serve as critical enablers for private sector innovation and technology to thrive. In Case A1, for example, the Senior Urban Policy Advisor stated, "*Our policy frameworks were designed to ensure that private tech firms could deploy smart city solutions, but we needed their technological expertise to make it happen.*" This integration of policy expertise with technological innovation underscores the critical role of each sector in complementing the other's strengths. Similarly, in Case B4, a Senior Analyst noted, "*Without the government's regulatory incentives for green infrastructure, we wouldn't have been able to justify the upfront capital investment needed to launch this project.*" Here, the private sector's financial capital and innovation were essential to scale the public sector's sustainability goals.

The synergy created through this combination of complementary resources is evident not only in the enhancement of individual capabilities but also in the optimization of collective resources. In the partnership case C, for instance, the integration of public sector infrastructure with private sector technology allowed for the efficient deployment of digital transformation training programs for public sector employees. The Head of Training and Development from case C4 provider explained, "*Our cutting-edge learning platforms were scaled up thanks to the government's established access to the public sector workforce.*" This integration allowed both sectors to maximize efficiency and achieve broader, scalable outcomes that neither could have achieved independently. Similarly, the Head of Data Services and Solutions from Case D3 highlighted how the public sector's infrastructure and private sector's technological solutions came together in a data-sharing platform, facilitating seamless information exchange and further enhancing the scalability and effectiveness of digital transformation and circular economy initiatives. Through these examples, the synergy created by leveraging complementary resources not only enhances the partnership's effectiveness but also ensures its scalability and long-term sustainability.

4.2. Co-creation of value through collaborative processes

The co-creation of value through collaborative processes is a critical feature of PPPs, particularly in projects involving digital transformation and the circular economy. Across the five case studies, it is evident that when public and private sectors work together through effective policy coordination, resource allocation, and operational expertise, they can develop innovative solutions that exceed what each could achieve independently. In Case A2, the Sustainability Policy Coordinator explained, "*Our partnership with the private sector allowed us to design a smart city initiative that neither side could have implemented on its own. The government's policy frameworks and the private sector's technological solutions were key to making this happen.*" This highlights the joint development of solutions, where the public sector's regulatory support and the private sector's innovation are seamlessly integrated to create scalable, sustainable outcomes.

Similarly, Case B exemplifies how shared decision-making and mutual investment in green infrastructure foster value creation. The Head of Sustainable Finance from B3 noted, "*We wouldn't have committed to this large-scale green infrastructure project without the government's matching investment and regulatory guarantees. It was a risk-sharing arrangement that made the project viable.*" This reflects the critical role of mutual investment and risk sharing in PPPs, where both sectors share the financial and operational risks involved, ensuring that the potential rewards are aligned with their long-term goals. Through this shared approach, both sectors not only manage risks more effectively but also benefit from the long-term value generated by the project.

In Case C1, the Head of Digital Transformation Strategy noted, "*The long-term partnership with the private sector has been crucial for building the digital capabilities within the public sector. Our shared goal is to ensure that digital transformation is sustainable.*" This illustrates the importance of long-term partnership goals, where both sectors commit to sustaining and scaling initiatives for mutual growth. These co-created solutions not only deliver immediate benefits but also contribute to resilience by ensuring that both sectors continue to evolve and adapt in response to future challenges. By integrating resources and coordinating efforts through collaborative processes, PPPs enable the co-creation of value that is more innovative, sustainable, and resilient than what each sector could achieve on its own.

4.3. Trust and governance enable effective collaboration

In PPPs, trust and clear governance structures are essential for ensuring the long-term success and effectiveness of collaborative efforts, particularly in complex fields like digital transformation and the circular economy. Across the five case studies, it is evident that effective governance and the building of trust between the public and private sectors underpin their ability to remain committed to the partnership, share resources, and navigate challenges. For instance, in Case D1, the Director of Data Governance emphasized, "*Our trust in the private sector's commitment to sustainability and transparency allowed us to jointly pursue a long-term data-sharing platform, which both sides rely on for operational success*." This highlights the crucial role of public trust and legitimacy, which are earned through consistent regulatory oversight and accountability, ensuring that the private sector upholds its obligations to the public.

In Case B3, the Fund Manager, Green Projects added, "*The government's performance expectations and their willingness to invest alongside us helped cement our commitment to this project. We felt the long-term goals were clearly aligned.*" This reflects the private sector's recognition of the importance of performance and delivery, where meeting shared objectives becomes possible through a strong, mutual commitment to the project's outcomes. In turn, this builds trust, enabling the public sector to rely on the private sector's innovation and delivery capabilities. Over time, governance structures in PPPs evolve through iterative adjustments to align incentives, enhance transparency, and reinforce mutual accountability. As partnerships mature, formal mechanisms such as joint performance reviews, adaptive contractual agreements, and co-governance committees emerge to sustain long-term collaboration. A Senior Planner for Infrastructure Development in Case D2 noted, "*Initially, decision-making was centralized within the government, but as trust grew, we transitioned to a shared governance model where both sectors had equal input in strategic planning.*" This evolution reflects how governance frameworks adapt to foster deeper collaboration, ensuring that both public and private actors remain committed to shared objectives.

Furthermore, effective collaboration in PPPs is deeply rooted in shared governance and decision-making, where both sectors have equally shared responsibility for directing the partnership. As observed in Case C2, the Senior Advisor on Digital Skills Development noted, "*Our joint task force has allowed us to make strategic decisions on digital training programs for public employees without delays, as both sectors have a voice in setting priorities*." This collaborative decision-making structure enhances flexibility, enabling both parties to adapt quickly to emerging needs, whether related to regulatory updates or unforeseen market shifts. The ability to share resources and knowledge—from technological innovations to regulatory insights—further strengthens the partnership. The Senior Health and Safety Officer from Case E3 explained, "*The shared knowledge and regular communication between our teams helped us refine waste management processes, ensuring we met both efficiency and environmental standards*." This example underscores the importance of resource and knowledge sharing, where the collaboration of both sectors leads to better decision-making, greater innovation, and more effective long-term solutions. Together, these elements of trust and governance ensure that both sectors remain aligned and committed to the shared goals of the partnership, allowing for sustained success and adaptability.

4.4. Mutual benefits and value creation drive sustainable outcomes

In PPPs, mutual benefits and value creation are key drivers of

sustainable outcomes. As the public and private sectors collaborate, the benefits derived from their joint efforts—such as economic growth, social impact, and innovative solutions—encourage a long-term commitment to the partnership. These shared benefits not only ensure the resilience of the partnership but also enable it to continuously create value, even amid challenges such as market shifts or political changes. In Case A1, the Senior Urban Policy Advisor stated, "*The success of our smart city initiative has been a win for both us and the private sector. It has improved our public services, while also fostering economic development, which in turn legitimizes our policies*." This illustrates how public welfare and societal impact align with policy influence and legitimacy, driving the continued support for the initiative across both sectors. The public sector gains legitimacy by demonstrating how partnerships contribute to public good, while the private sector benefits from the market expansion and competitive advantage offered by access to new markets and public infrastructure.

Similarly, Case B3 emphasizes the mutual benefits gained from market expansion and innovation leadership. The Senior Investment Director, Green Infrastructure noted, "*Our involvement in this green infrastructure project has opened new market opportunities and strengthened our brand as a leader in sustainable development*." This reflects how the private sector's innovation not only leads to competitive advantage but also enhances brand value. At the same time, these partnerships help both sectors create lasting solutions with positive environmental and social impacts. The collaboration results in more efficient and sustainable resource management practices that benefit society at large.

The resulting sustainable outcomes are driven by the partnership's focus on long-term resilience and scalability. In Case D2, the Smart Cities and Data Integration Specialist remarked, "*The scalability of the data-sharing platform we've built ensures it can continue to evolve and meet future needs, whether it's regulatory changes or technological advancements*." This shows how solutions developed through PPPs are designed to be adaptable to future challenges, ensuring their continued relevance. Furthermore, both sectors are committed to continuous improvement, as seen in Case E1, where the Director of Public Health Programs said, "*We regularly assess the waste management solutions and refine them to stay ahead of new environmental standards*." This ongoing adaptation ensures that the solutions remain sustainable and continue to provide value over time, supporting the long-term success of the partnership. Thus, the mutual benefits derived from these collaborations enable both sectors to contribute to resilient, scalable, and sustainable outcomes, ensuring that the partnership remains effective in the long run.

5. Discussion

5.1. Triggers and challenges in synergy creation through complementary resources

The transition from complementary resources to synergy creation in PPPs plays a critical role in enabling both sectors to leverage their distinct strengths. This process involves aligning resources such as regulatory frameworks and private sector innovation, which can lead to a more efficient and effective partnership (Campmas et al., 2022; Sheng et al., 2020). The empirical findings from the five case studies illustrate that when both the public and private sectors align their long-term strategic goals with short-term tactical milestones, the partnership becomes more capable of overcoming the inherent challenges that arise from differing operational timelines. As seen in partnership case A, where the partnership between government entities and private tech firms to develop smart city solutions was marked by strategic alignment, the Senior Regulatory Compliance Officer from case A2 noted, "*Our long-term goal was to create a sustainable smart city, but it was essential to break down the milestones into actionable steps that private sector partners could work with on a shorter timeline*." This approach helped maintain momentum and reduced the risk of misaligned expectations, which could otherwise hinder the potential for synergy creation.

Additionally, the technological and policy innovation that governments actively promote plays a significant role in fostering synergies (Zhao et al., 2018; Mazzucato and Robinson, 2018). Policies that incentivize private sector innovation, such as those seen in Case B, help ensure that cutting-edge technologies align with public sector goals. The Director of Sustainable Infrastructure Investments in Case B4 emphasized, "*Without the government's green tech policies, we would not have been able to justify the investment needed for infrastructure projects that are both profitable and sustainable*." These policies serve as a foundation for public-private collaborations, especially in emerging sectors like clean technologies and digital transformation, where the private sector often drives the innovation, but the public sector provides the regulatory framework to ensure that these innovations contribute to the public good. Therefore, effective synergy creation in PPPs is not solely reliant on shared vision but also on technological and policy frameworks that catalyze innovation and resource integration.

However, challenges remain that hinder the seamless integration of complementary resources. A major challenge, as highlighted in the findings, is the alignment of timelines. The public sector's emphasis on long-term strategic planning often contrasts with the private sector's focus on achieving quick returns on investment (Laplane and Mazzucato, 2020; Khan et al., 2020). In Case D2, the Senior Planner for Infrastructure Development remarked, "*While we aim for long-term sustainability, the private sector is often more concerned with short-term market outcomes, which sometimes results in a mismatch of expectations regarding project timelines*." This temporal misalignment can lead to frustrations on both sides, as long-term projects may experience delays, and the private sector may retreat if financial returns are not realized quickly. Additionally, institutional rigidities within both sectors—such as the slow adoption of digital technologies by the public sector and the private sector's reluctance to adapt to public regulatory norms—further complicate the efficient integration of resources. In Case E5, the Chief Executive Officer noted, "*We faced significant barriers due to the government's rigid regulatory frameworks, which delayed our ability to innovate and scale quickly*." These institutional barriers reduce the agility of both sectors, preventing them from realizing the full potential of resource integration. Despite these challenges, the evidence suggests that overcoming such barriers can lead to enhanced synergy creation, especially when both sectors are committed to strategic alignment and collaboration. The integration of public resources (regulatory frameworks, infrastructure) with private sector innovation (technology, capital) creates value that exceeds the individual contributions of each sector. Therefore, it is proposed that:

Proposition 1. The transition from complementary resources to synergy creation in PPPs is driven by the alignment of long-term and short-term goals and technological and policy innovation, while challenges like timeline misalignment and institutional rigidities must be overcome to achieve optimal synergy.

5.2. Triggers and challenges in co-creation of value through collaborative processes

The transition from collaborative processes to co-creation of value in PPPs is integral to achieving outcomes that transcend the individual contributions of both sectors. Collaborative leadership and the establishment of shared decision-making structures have been identified as essential triggers for this transition (Verweij and Satheesh, 2023; Scupola and Mergel, 2022). The empirical findings across the five case studies demonstrate that joint leadership teams, where both public and private sector representatives play an active role, significantly enhance the coherence of goals and ensure efficient resource allocation. For instance, in Case C1, the Director of *E*-Governance highlighted, "*The collaboration between our leadership team and the private sector's executives allowed us to streamline decision-making and ensure that both parties were equally invested in the project's success*." This shared leadership fosters a

sense of ownership and encourages commitment to long-term goals, which is crucial for value co-creation. The private sector's innovation capacity and the public sector's policy expertise are both crucial, but their integration requires effective leadership that facilitates collaboration rather than division.

Furthermore, the formal mechanisms for resource and knowledge exchange also play a pivotal role in enabling co-creation (Dentoni et al., 2016; Panda, 2016). Joint task forces and innovation hubs—institutions that encourage continuous resource integration and knowledge sharing—help both sectors align their capabilities towards common goals. In Case B5, the Manager of Green Building Solutions explained, "*The creation of an innovation hub, where both teams could collaborate, facilitated the integration of public sector policy frameworks with private sector technologies, allowing us to innovate more effectively*." This integration of resources is essential for targeted co-creation, where both sectors contribute complementary strengths to achieve innovative solutions that neither could create independently.

Despite these triggers, the transition to co-creation of value is often hindered by several challenges. One major issue is decision-making delays and conflicts, which arise from the complexity of joint decision-making. As identified in the case studies, public sector decision-making processes are often encumbered by political pressures and bureaucratic procedures, while the private sector is driven by market pressures and the need for quick returns on investment. In Case D1, the Senior Security and Compliance Officer noted, "*While we were focused on long-term societal benefits, the private sector wanted quicker returns, and this mismatch in priorities caused delays and frustrations*." These delays in decision-making can slow down innovation cycles and hinder the timely execution of projects, thus undermining the co-creation process.

Another challenge is the imbalance of power and influence between the two sectors (Marana et al., 2020). The public sector typically holds regulatory authority, while the private sector often controls key resources such as capital and technology. This imbalance can create dominance struggles in decision-making, where the public sector's regulatory authority might stifle the private sector's innovation, or conversely, the private sector's resource control might lead to an imbalance in priorities. For example, in Case E3, the Senior Health and Safety Officer remarked, "*We often felt that the government's regulatory constraints were slowing down our ability to innovate, even though we were providing the capital and technology*." This power imbalance can undermine the effectiveness of the partnership and hinder the collaborative processes necessary for co-creating value.

Proposition 2. The transition from collaborative processes to co-creation of value in PPPs is driven by collaborative leadership and effective resource and knowledge exchange, while challenges such as decision-making delays, conflicts, and an imbalance of power and influence must be managed to enable successful co-creation.

5.3. Triggers and challenges in effective collaboration through trust and governance

The transition from trust and governance to effective collaboration in PPPs is essential for achieving sustained success in complex projects (Aben et al., 2021; Esposito and Dicorato, 2020). Effective collaboration hinges on both sectors' ability to build mutual trust and establish transparent governance structures that ensure accountability and alignment of goals. As identified in the case studies, participatory governance models, where both public and private sectors are engaged not only in decision-making but also in the implementation of initiatives, play a crucial role in enhancing collaboration and trust. For example, in Case C1, the Head of Digital Transformation Strategy explained, "*The collaborative leadership between public and private teams, where both sectors were equally involved in implementation, ensured that we maintained open communication and trust throughout the process*." This approach fosters a deeper sense of ownership and encourages both sectors to actively contribute, thereby strengthening the partnership and driving the successful co-delivery of outcomes.

Moreover, transparency in performance metrics is a critical trigger for building and maintaining trust. Beyond the general transparency that helps establish initial trust, it is essential that both the public and private partners agree on clear and measurable performance metrics that track both financial and social impacts (Khan et al., 2020; Rybnicek et al., 2020). In Case B3, the Head of Sustainable Finance noted, "*By aligning our performance metrics with the public sector's broader societal goals, we ensured that the project's impact was not just financial but also socially valuable, which strengthened our relationship*." This transparency ensures that both parties are accountable for their contributions and that their efforts are directed towards common objectives. The alignment of mutual expectations and performance tracking provides a foundation for long-term collaboration and helps prevent misunderstandings or perceptions of inequity.

However, several challenges impede the smooth transition from trust and governance to effective collaboration (Esposito and Dicorato, 2020). One significant challenge identified in the case studies is trust erosion due to mismatched expectations. This arises when one party feels that the other is either too controlling or not fulfilling its commitments, which can undermine trust and hinder collaboration. For instance, in Case D1, the Senior Security and Compliance Officer observed, "*The private sector often felt constrained by our regulations, while we felt that their focus on profitability sometimes overshadowed our long-term goals. This misalignment created tensions that eroded trust*." These differing expectations regarding the degree of control each sector should exert over the project can lead to conflict, reducing the effectiveness of collaborative efforts.

Another challenge is the difficulty in managing cultural differences between the public and private sectors (Balsalobre-Lorente et al., 2024). As highlighted in Case E4, the Director of Biomedical Waste Management shared, "*The government's bureaucratic processes sometimes clashed with our need for operational flexibility, causing delays in decision-making and resource sharing.*" The culture clash between the rigidity of government structures and the agility of private sector operations often leads to friction that impedes both decision-making and resource sharing. This cultural divide can limit the flexibility required for effective collaboration and delay the achievement of key project milestones.

Proposition 3. The transition from trust and governance to effective collaboration in PPPs is facilitated by participatory governance models and transparency in performance metrics, while challenges such as trust erosion due to mismatched expectations and difficulty in managing cultural differences must be addressed to achieve successful collaboration.

5.4. Triggers and challenges in achieving sustainable outcomes through mutual benefits and value creation

The transition from mutual benefits and value creation to sustainable outcomes PPPs is critical for ensuring the longevity and success of collaborative projects, particularly in areas like digital transformation and circular economy initiatives (Dentoni et al., 2016; Khan et al., 2020). As highlighted by the case studies, the ability of both public and private sectors to adapt to external shocks, such as economic downturns or regulatory changes, plays a key role in facilitating sustainable outcomes. This adaptive capacity is essential for maintaining the continuity of projects under dynamic conditions. For instance, in Case A1, Senior Urban Policy Advisor noted, "*The ability to adapt to changing market conditions was essential in keeping our smart city project on track. The public and private sectors worked closely to adjust to new technological advances and regulatory shifts*." This aligns with the literature, which emphasizes that resilience frameworks in PPPs enable both sectors to navigate uncertainties, thus ensuring the sustainability of initiatives even when faced with external challenges.

Furthermore, inclusive stakeholder engagement is a critical trigger for sustainable outcomes. Involving external stakeholders, such as local communities, NGOs, and international organizations, early on ensures that the project's goals align with broader societal needs (De Schepper et al., 2014; Joglekar et al., 2022). The inclusion of these stakeholders not only enhances the legitimacy of the project but also provides valuable insights into sustainability measures that reinforce the long-term viability of the partnership. As noted in Case B3, Head of Sustainable Finance explained, "*Engaging with local communities and NGOs helped us refine our green infrastructure project to better serve public needs, making the initiative more resilient to long-term social and environmental changes*." This finding aligns with the work of De Schepper et al. (2014) who argue that stakeholder engagement ensures that projects meet societal expectations and contribute to the sustainable development goals of the partnership.

Despite these positive triggers, several challenges impede the transition from mutual benefits and value creation to sustainable outcomes. A significant challenge is financial sustainability (Laplane and Mazzucato, 2020; Khan et al., 2020). Although PPPs often generate immediate value, securing the long-term financial sustainability of projects—especially those requiring large-scale infrastructure investments—remains difficult. In Case D2, Smart Cities and Data Integration Specialist commented, "*While we achieved initial success in the smart city project, securing the ongoing funding required to maintain and scale it proved challenging. We need continuous investment from both the public and private sectors to ensure long-term success*." The ongoing financial commitment from the private sector is often uncertain, particularly when the return on investment is slow or unpredictable. The literature also highlights that private sector investors may hesitate to continue their involvement if short-term returns are not achieved, which threatens the long-term financial sustainability of the project.

Another challenge is the complexity in measuring long-term impact. While PPPs can deliver significant social and environmental benefits, ensuring the long-term sustainability of these impacts is often difficult. Governments, driven by political pressures to deliver immediate results, may find it challenging to measure and sustain the long-term impact of projects (Rybnicek et al., 2020; Gumbo and Moyo, 2020). Similarly, private companies focused on short-term profit maximization may prioritize immediate returns over long-term social or environmental outcomes. In Case E5, Chief Executive Officer expressed, "*The focus on short-term results often conflicts with the long-term sustainability goals we're trying to achieve. It's difficult to balance both objectives when the focus shifts towards quick returns*." This finding resonates with Esposito and Dicorato (2020), who highlights the inherent tension in PPPs between short-term profitability and the pursuit of long-term societal benefits.

Proposition 4. The transition from mutual benefits and value creation to sustainable outcomes in PPPs is driven by adaptive capacity and inclusive stakeholder engagement, while challenges like financial sustainability and measuring long-term impact must be overcome to ensure lasting success.

Fig. 2 outlines the conceptual framework.

6. Concluding remark

This study provides valuable insights into the dynamics of PPPs in driving digital transformation and circular economy initiatives. The findings highlight key triggers and challenges in the transition from complementary resources to synergy creation, co-creation of value, and sustainable outcomes. The research offers both theoretical contributions, expanding the understanding of collaborative advantage in PPPs, and practical implications, offering actionable strategies for practitioners to enhance collaboration and ensure long-term success in complex partnerships.

6.1. Theoretical contributions

This study significantly extends the existing literature on PPPs, particularly by integrating CAT to explain the dynamics of collaboration, resource integration, and sustainable outcomes. The research offers key theoretical insights into how synergy creation, co-creation of value, and sustainability are achieved within PPPs, with a particular focus on the role of triggers and challenges in these transitions.

One of the key theoretical contributions of this study lies in refining the concept of synergy creation within PPPs. While prior literature has acknowledged the importance of complementary resources, this research emphasizes that strategic alignment between long-term goals and short-term milestones is a critical trigger for synergy creation (Panda, 2016; Dentoni et al., 2016). The findings show that this alignment allows both public and private sectors to overcome the challenges of differing timelines and institutional rigidities, which have traditionally hindered the seamless integration of resources. By highlighting the role of technological and policy innovation (Khan et al., 2020; Ishaq et al., 2024), this study extends CAT (Huxham and Vangen, 2000; Hansen and Nohria, 2004) by demonstrating how regulatory frameworks and private sector innovation can work synergistically to create value beyond the individual contributions of each sector. The research builds on existing theories by suggesting that effective synergy creation is not just about resource complementarity but also about adaptive strategies that can mitigate challenges such as institutional rigidities and mismatched timelines.

In terms of co-creation of value, the study contributes to the theoretical understanding of how collaborative processes and joint leadership facilitate the integration of resources and knowledge across sectors (Zhao et al., 2018; Verweij and Satheesh, 2023). While earlier studies have examined the role of resource sharing in value creation (Scupola and Mergel, 2022), this research emphasizes the importance of collaborative leadership and the establishment of shared decision-making structures. By highlighting the triggers of leadership engagement and resource exchange, the study demonstrates how joint governance fosters mutual investment, shared accountability, and effective decision-making, all of which are essential for co-creating value. This contribution expands on existing collaborative theories by focusing on how leadership dynamics can overcome the challenges posed by decision-making delays, conflicts, and imbalance of power in the partnership.

Regarding trust and governance, the research extends the literature by offering a more dynamic view of governance structures in PPPs. Traditional governance models have largely emphasized compliance and accountability (Esposito and Dicorato, 2020; Aben et al., 2021); however, this study demonstrates that trust-building and transparent governance are not just static enablers of collaboration but also dynamic drivers of effective collaboration. The findings indicate that participatory governance models, where both public and private sectors are actively engaged in both decision-making and implementation, can overcome the challenge of trust erosion caused by mismatched expectations. Moreover, by integrating the concept of performance metrics into governance structures, the study expands the theoretical understanding of how transparent accountability mechanisms can foster long-term collaboration (Verweij and Satheesh, 2023; Sheng et al., 2020). This provides a more robust framework for understanding how trust and governance operate in complex PPPs, especially in contexts requiring adaptability and flexibility.

6.2. Practical implications

This research offers several key practical contributions for enhancing the design, implementation, and management of PPPs, particularly in sectors driven by digital transformation and circular economy goals. The findings provide actionable insights for policymakers, public sector managers, and private sector leaders on how to optimize collaboration, overcome challenges, and achieve long-term, sustainable outcomes in

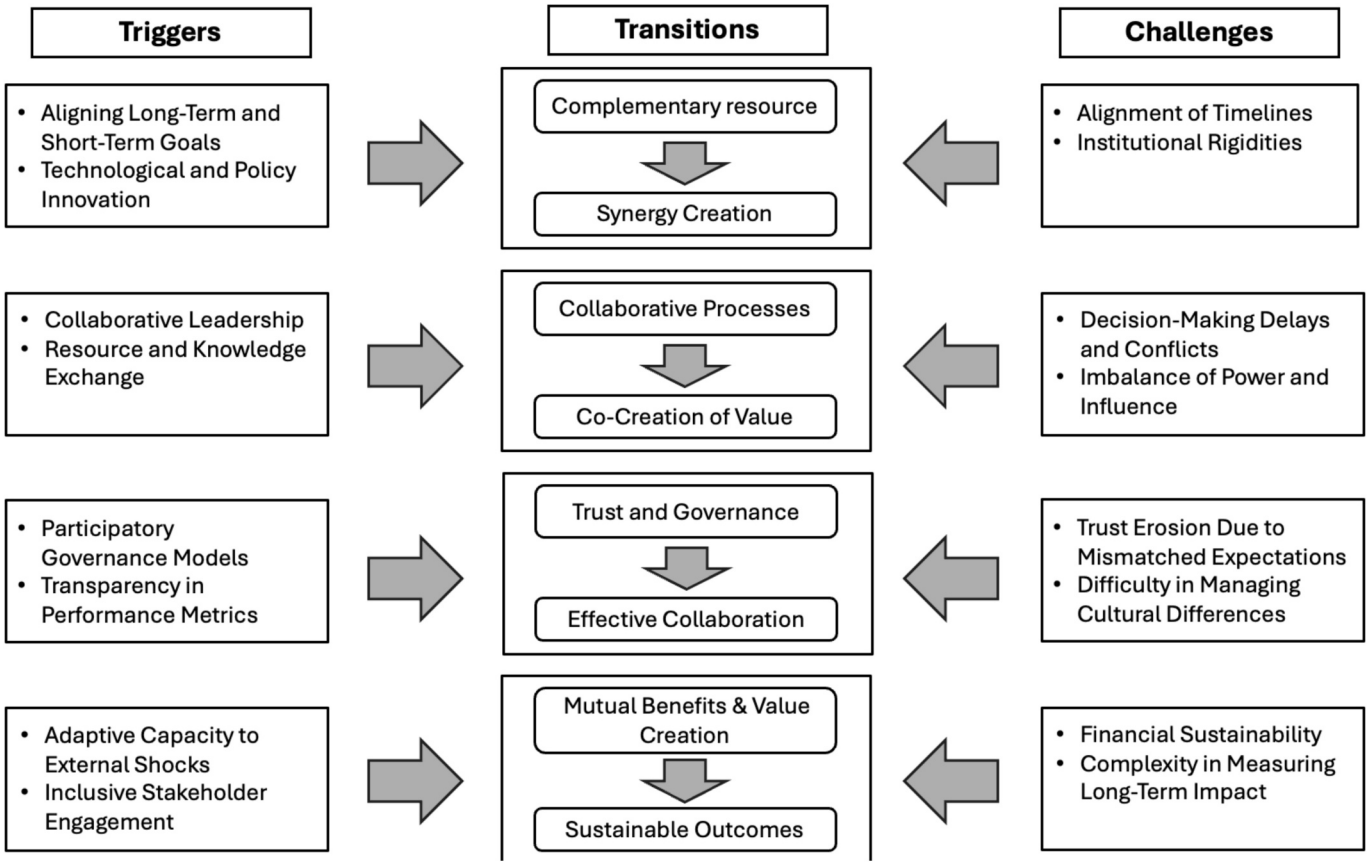

Fig. 2. Conceptual framework.

PPPs.

One of the primary practical contributions of this research is the emphasis on the need for strategic alignment between public and private sector partners. The study demonstrates that for PPPs to be successful, there must be a clear understanding of both long-term strategic objectives and short-term tactical milestones. Public and private partners must engage in continuous dialogue to ensure that their goals are aligned, particularly when navigating the inherent differences in operational timelines. Public sector managers can use this insight to design PPPs that address both immediate project goals and long-term sustainability while ensuring that all partners are on the same page regarding project milestones. Additionally, the role of technological and policy innovation as a key enabler of synergy creation suggests that governments should actively foster regulatory frameworks that incentivize innovation in the private sector, particularly in areas like clean technologies and digital solutions.

The research also provides practical guidance on collaborative leadership and the importance of shared decision-making structures. By establishing joint leadership teams with active representation from both sectors, PPPs can ensure that resources are allocated efficiently, goals are coherent, and both parties feel equally invested in the project's success. This insight is critical for project managers in both public and private sectors, as it highlights the need for leadership structures that foster joint ownership and responsibility. This model of collaborative leadership can help mitigate issues related to decision-making delays and conflicts, which are common in traditional PPP structures where power is often imbalanced. The practical implication is that both sectors need to build trust not only through transparency but also by being equally engaged in governance and implementation processes.

Moreover, the findings emphasize the importance of adaptive governance and trust-building mechanisms. The research underscores that transparency and shared accountability are key to long-term collaboration. Governments and private companies must develop transparent performance metrics that measure not only financial outcomes but also social and environmental impacts. For public sector leaders, this means incorporating clear accountability frameworks into PPP contracts and ensuring that both sectors are committed to meeting agreed-upon goals. On the private sector side, this research highlights the need for performance-driven relationships, where companies are held accountable not only for financial outcomes but also for social responsibility and long-term sustainability. This has significant implications for contract design, as it calls for a more nuanced approach to performance evaluation that integrates both financial and non-financial indicators.

The research also provides a roadmap for navigating the challenges of financial sustainability and measuring long-term impact. By focusing on inclusive stakeholder engagement, the study suggests that PPPs can increase the likelihood of sustaining projects over time. This can be particularly important in sectors where social outcomes and community involvement are central to the success of the partnership, such as in green infrastructure or medical waste management projects. Engaging local communities, NGOs, and other external stakeholders early in the process ensures that projects are aligned with societal needs, improving project legitimacy and long-term impact. This practical advice is vital for private investors and public policymakers, as it helps ensure that PPPs are not just economically viable but also socially responsible and environmentally sustainable.

Lastly, the study emphasizes the importance of adaptive capacity in overcoming external shocks and ensuring the long-term success of PPPs. While these partnerships offer significant opportunities for innovation and sustainability, they also present challenges such as power imbalances and the risk of excessive public sector dependency on private actors. Without careful governance mechanisms, PPPs may reinforce asymmetrical relationships where private sector entities exert

disproportionate influence over decision-making, potentially undermining public interest goals. To mitigate these risks, policymakers must establish clear accountability frameworks, transparent contractual agreements, and mechanisms for equitable decision-making to ensure that PPPs remain balanced and sustainable over time. Furthermore, fostering flexibility in governance structures and ensuring that resources are allocated in a way that allows for quick adaptation to changing circumstances is essential for resilience.

6.3. Limitations and future research direction

While this study provides valuable insights into the dynamics of PPPs in driving digital transformation and circular economy initiatives, several limitations must be acknowledged. These limitations not only highlight areas for caution in interpreting the findings but also open avenues for future research.

First, the scope of this study is limited to five case partnerships in developing countries. While this case-based approach allows for an in-depth exploration of PPPs, it inherently limits the generalizability of findings beyond these specific contexts. The focus on developing countries means that regulatory challenges, resource constraints, and institutional conditions shape the observed outcomes, which may differ in more developed economies with stronger governance structures. Future research could adopt a comparative approach by analyzing PPPs in both developed and developing contexts to examine how regulatory environments, cultural factors, and economic conditions influence collaboration effectiveness. Additionally, expanding the number of cases across diverse industries would allow for greater external validity and identification of broader trends.

Second, the study relied on interviews as the primary data source, which, while providing rich qualitative insights, introduces potential subjectivity and response bias. Participants' perspectives may be influenced by organizational priorities, strategic interests, or individual experiences, potentially shaping how they interpret PPP effectiveness. Although triangulation with archival documents mitigated this to some extent, future research could incorporate quantitative measures—such as network analysis of partnership interactions, financial performance indicators, or survey-based assessments of stakeholder satisfaction—to provide a more objective evaluation of PPP outcomes. Moreover, longitudinal studies tracking PPPs over time would be beneficial in assessing how trust, governance structures, and collaboration mechanisms evolve, offering deeper insights into the sustainability of these partnerships.

Third, while the study captures a diverse range of PPP types, it does not fully account for the unique challenges faced in other sectors, such as healthcare, education, or transportation. Different industries may involve distinct regulatory requirements, stakeholder expectations, and collaboration dynamics that could influence PPP success. Future research could examine PPPs in these underexplored sectors to determine whether the mechanisms identified in this study apply universally or require sector-specific adaptations. Additionally, investigating multi-sector PPP collaborations, where various industries converge (e.g., digital health infrastructure or sustainable transportation initiatives), could provide a more comprehensive understanding of how cross-industry partnerships function and scale over time.

CRediT authorship contribution statement

Umair Tanveer: Writing – review & editing, Writing – original draft, Supervision, Resources. **Thinh Gia Hoang:** Writing – review & editing, Visualization, Resources, Methodology, Investigation. **Shamaila Ishaq:** Formal analysis, Data curation, Conceptualization. **Raja Usman Khalid:** Writing – review & editing, Formal analysis.

Data availability

Data will be made available on request.

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