

Circular Supply Chain Management Capabilities and Organizational Resilience: Examining Their Role in Enhancing Sustainable Business Performance among Manufacturing SMEs

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Abstract

The increased environmental pressures, limited resources, supply chain disruptions, changes in regulations, and the rising demand for sustainable manufacturing processes have significantly affected small- and medium-sized enterprises (SMEs) in the manufacturing sector. Circular supply chain management (CSCM) has become one of the significant approaches to improve the circularity of resources, reduce waste, recover products, recycle the materials, utilize materials, and collaborate with other firms in the supply chain network. The current review aims to analyze the relationships between capabilities in the area of circular supply chain management, resilience of enterprises, and sustainable performance of SMEs in the manufacturing sector. The review is aimed at synthesizing findings from updated literature on circular supply chain management capabilities, including circular procurement, eco-design, reverse logistics, resource recovery, collaboration with suppliers, usage of modern technologies in the supply chain, and practices in closed-loop supply chain management. One of the most important aspects of the research is to explore organizational resilience as a mechanism through which the application of circular capabilities can help SMEs to manage the disruptions in supply chains and continue operations. Moreover, the article aims to demonstrate how circular capabilities impact all components of sustainable performance. The review further explores how these capabilities contribute to economic, environmental, and social dimensions of sustainable business performance. Existing literature indicates that integrating circular practices with resilience-oriented capabilities can improve resource productivity, operational flexibility, innovation, risk management, and long-term competitiveness. However, gaps remain regarding empirical evidence from manufacturing SMEs, especially in developing economies and emerging industrial contexts. The paper identifies these research gaps and proposes directions for future studies focusing on integrated circularity, resilience, digitalization, and sustainable performance frameworks.

Keywords: Circular Supply Chain Management; Organizational Resilience; Sustainable Business Performance; Manufacturing SMEs; Circular Economy; Supply Chain Capabilities



1. INTRODUCTION

Manufacturing small and medium-sized enterprises (SMEs) play a significant role in employment generation, industrial development, innovation, and economic growth. However, these enterprises increasingly operate under conditions of resource scarcity, environmental regulations, volatile markets, supply disruptions, and changing customer expectations. Conventional linear supply chains, generally based on the “take–make–use–dispose” model, intensify resource consumption and waste generation and create considerable environmental pressure. In response, the circular economy (CE) has emerged as an alternative economic paradigm that seeks to minimize resource depletion and waste by maintaining products, components, and materials at their highest possible value for as long as possible. Within this context, circular supply chain management (CSCM) extends circular economy principles across procurement, production, distribution, consumption, recovery, reuse, remanufacturing, and recycling activities [1].

The transition toward circular supply chains requires organizations to develop specific capabilities that enable them to redesign conventional processes and establish closed-loop flows of materials, information, and value. These capabilities may include sustainable procurement, eco-design, green manufacturing, reverse logistics, waste recovery, resource efficiency, supplier collaboration, technological integration, and customer engagement. Unlike large corporations, SMEs often face limitations in financial resources, technological infrastructure, skilled personnel, and managerial expertise, which can make the implementation of circular practices particularly challenging. Nevertheless, SMEs can benefit from circular supply chain practices through reduced material costs, improved resource utilization, enhanced innovation, and stronger environmental performance. Therefore, developing circular supply chain management capabilities can become an important strategic mechanism for improving the competitiveness and sustainability of manufacturing SMEs [2]. At the same time, manufacturing SMEs must be capable of responding effectively to unexpected disruptions. Events such as pandemics, geopolitical instability, natural disasters, transportation interruptions, raw-material shortages, and fluctuations in market demand can significantly affect supply chain continuity. Organizational resilience refers to an organization's ability to anticipate, absorb, adapt to, and recover from disruptive events while maintaining essential operations and performance. Resilient organizations are generally characterized by flexibility, adaptability, preparedness, collaboration, resource availability, and the capacity to rapidly reconfigure operations. In the manufacturing environment, resilience has become particularly important because supply chain disruptions can affect production schedules, inventory availability, customer satisfaction, and financial stability. Consequently, organizational resilience represents an important organizational capability for converting circular supply chain practices into long-term business value [3].

The relationship between circularity and resilience is particularly relevant because circular supply chains can provide alternative sources of materials and greater flexibility in resource utilization. Practices such as recycling, remanufacturing, product recovery, local sourcing, reverse logistics, and supplier collaboration may reduce dependence on limited virgin



resources and geographically concentrated suppliers. Similarly, digital technologies such as Internet of Things (IoT), artificial intelligence, blockchain, cloud computing, and data analytics can improve visibility and coordination across circular supply chain networks. These capabilities can help SMEs identify disruptions earlier, optimize resource allocation, diversify supply options, and respond more effectively to changing operating conditions. Thus, circular supply chain capabilities may contribute not only to environmental sustainability but also to organizational resilience [4].

Sustainable business performance provides a broader basis for evaluating the effectiveness of circular supply chain transformation. Sustainable performance encompasses economic outcomes, environmental improvements, and social contributions. For manufacturing SMEs, successful circular supply chain practices can potentially reduce operational costs, minimize waste, improve resource productivity, stimulate innovation, strengthen stakeholder relationships, and enhance corporate environmental responsibility. However, achieving these outcomes requires more than adopting individual circular practices. SMEs need to integrate circular capabilities with organizational structures, technological resources, knowledge, collaboration mechanisms, and resilience-oriented strategies. The ability to transform circular initiatives into measurable and sustained performance therefore remains an important research issue [5]. Based on these considerations, this review examines the role of circular supply chain management capabilities and organizational resilience in enhancing sustainable business performance among manufacturing SMEs. The review focuses on the major dimensions of CSCM capabilities, the nature and importance of organizational resilience, and the mechanisms through which these factors can influence economic, environmental, and social performance. It also identifies limitations and gaps in existing research, particularly concerning SME-specific empirical evidence, integration of circularity with resilience, technological enablers, and the measurement of sustainable performance. By synthesizing the existing literature, this review aims to provide a comprehensive conceptual understanding of how manufacturing SMEs can combine circular supply chain capabilities with organizational resilience to achieve more sustainable, adaptable, and competitive business operations.

2. CONCEPTUAL FOUNDATIONS OF CIRCULAR SUPPLY CHAIN MANAGEMENT

Circular Supply Chain Management (CSCM) has emerged from the integration of circular economy principles with traditional supply chain management. Conventional supply chains generally follow a linear model in which raw materials are extracted, transformed into products, distributed to consumers, and eventually discarded as waste. This approach has contributed substantially to resource depletion, environmental degradation, greenhouse gas emissions, and increasing waste generation. In contrast, the circular economy seeks to maintain the value and utility of products, components, and materials for extended periods by emphasizing reduction, reuse, repair, refurbishment, remanufacturing, and recycling. CSCM operationalizes these principles across supply chain activities by creating systems in which material and product flows can be recovered and reintegrated into production processes [6].

The conceptual foundation of CSCM is therefore based on the transformation of supply chains from predominantly linear systems into closed-loop and regenerative systems. A circular supply chain incorporates both forward and reverse flows. Forward flows involve conventional activities such as sourcing, manufacturing, distribution, and consumption, whereas reverse flows involve the collection, inspection, recovery, repair, remanufacturing, recycling, and reuse of products and materials. The integration of these flows enables organizations to reduce dependence on virgin resources while creating additional economic value from products that would otherwise become waste [7]. Consequently, CSCM is not limited to waste management but represents a broader strategic approach for redesigning supply chain structures, processes, relationships, and business models.

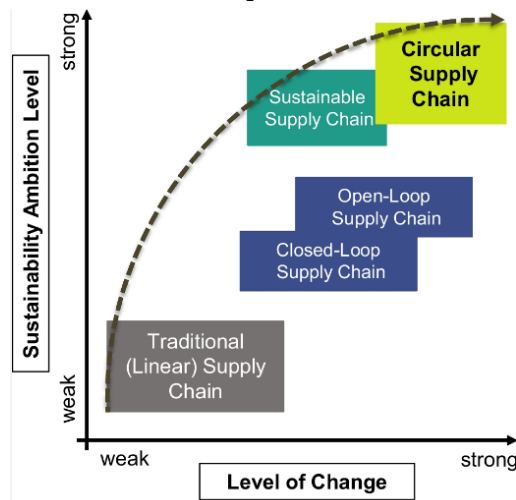


Figure 1. Evolution from Traditional (Linear) to Circular Supply Chain [7]

The figure 1 illustrates how increasing sustainability ambition and the level of change progressively transform traditional supply chains into closed-loop, open-loop, sustainable, and ultimately circular supply chains. An important conceptual dimension of CSCM is resource efficiency. Circular supply chains aim to minimize the consumption of primary materials and energy while maximizing the productive use of existing resources. Resource efficiency can be achieved through improved production planning, material optimization, waste minimization, energy-efficient manufacturing, product-life extension, and recovery of valuable components. For manufacturing SMEs, this dimension is particularly important because limited financial and material resources can make production efficiency a major determinant of competitiveness. Efficient resource utilization can simultaneously support environmental objectives and reduce operational expenditure.

Another foundation of CSCM is closed-loop supply chain management, which combines forward logistics with reverse logistics. Reverse logistics facilitates the movement of used products, components, packaging, and materials from customers back to manufacturers or other recovery facilities. Depending on their condition and residual value, returned products may be reused, repaired, refurbished, remanufactured, or recycled. This process allows firms to recover economic value while reducing the amount of material entering disposal systems

[8]. Effective reverse logistics therefore represents an essential mechanism for translating circular economy principles into operational supply chain practices.

Product and process design also constitute important foundations of circular supply chains. Traditional product development often emphasizes functionality and production cost without adequately considering end-of-life recovery. Circular design, by contrast, considers durability, modularity, repairability, recyclability, disassembly, and material selection throughout the product-development process. Designing products for longer life and easier recovery can improve the feasibility of reverse logistics and material recovery. Manufacturing SMEs can therefore incorporate circular design principles to create products that generate lower environmental impacts while offering opportunities for service innovation and extended customer relationships.

CSCM also depends strongly on collaboration among supply chain stakeholders. Circularity cannot generally be achieved by a single organization because the recovery and reuse of materials require coordination among suppliers, manufacturers, logistics providers, customers, recyclers, technology providers, and regulatory institutions. Information sharing, joint planning, supplier development, and collaborative innovation can improve visibility of material flows and facilitate the recovery of products and resources. Such collaboration is particularly relevant for SMEs because partnerships can provide access to technological knowledge, recovery infrastructure, financial resources, and specialized capabilities that may be unavailable internally [9].

Digitalization provides another important conceptual foundation. Technologies such as IoT, cloud computing, artificial intelligence, blockchain, big-data analytics, and digital platforms can improve the traceability and visibility of products and materials throughout their life cycles. Real-time information can support demand forecasting, inventory management, product tracking, predictive maintenance, and reverse logistics. Digital technologies can therefore strengthen the coordination and transparency required for effective circular supply chain implementation.

Finally, CSCM should be understood as a multidimensional concept that integrates economic, environmental, and social objectives. Its purpose is not merely to reduce waste but to create sustainable value while maintaining operational and economic viability. Economic benefits may arise from material savings, new revenue streams, and improved resource productivity; environmental benefits include reduced waste, emissions, and resource consumption; and social benefits may include improved employment opportunities, stakeholder engagement, and responsible production. Thus, CSCM provides a strategic foundation through which manufacturing SMEs can transition from resource-intensive linear models toward more resilient and sustainable supply chain systems [10].

3. CIRCULAR SUPPLY CHAIN MANAGEMENT CAPABILITIES IN MANUFACTURING SMEs

Circular Supply Chain Management capabilities refer to the organizational resources, knowledge, processes, technologies, and relational competencies that enable firms to implement and continuously improve circular practices across their supply chains. For

manufacturing SMEs, these capabilities are particularly significant because circular transformation requires organizations to move beyond isolated environmental initiatives and integrate circularity into procurement, product design, manufacturing, logistics, customer management, and recovery processes. The development of these capabilities can help SMEs improve resource efficiency while simultaneously strengthening competitiveness and sustainable business performance [11].

One of the fundamental capabilities is circular procurement capability. Conventional procurement primarily focuses on price, quality, and delivery, whereas circular procurement considers the environmental characteristics, durability, recyclability, reparability, and life-cycle impacts of purchased materials and products. SMEs can develop this capability by selecting suppliers that use sustainable materials, provide recyclable components, minimize packaging, and follow responsible production practices. Long-term relationships with environmentally responsible suppliers can further improve material quality and reduce supply-related environmental risks. Circular procurement can also encourage suppliers to participate in take-back arrangements and product recovery initiatives.

A second important capability is eco-design and circular product development. Manufacturing SMEs can incorporate durability, modularity, reparability, recyclability, and ease of disassembly into product-development processes. Such design characteristics increase product longevity and make components easier to recover at the end of their useful life. Eco-design can also stimulate innovation by encouraging firms to develop products with lower material requirements, improved energy efficiency, and alternative sustainable materials. For SMEs, this capability can provide opportunities to differentiate products and respond to increasing customer demand for environmentally responsible offerings [12].

Green manufacturing and resource-efficiency capability represents another essential dimension. This capability involves reducing material waste, energy consumption, water usage, emissions, and unnecessary production activities. Techniques such as lean manufacturing, cleaner production, energy-efficient equipment, waste segregation, and process optimization can contribute to circularity. By integrating environmental objectives with production efficiency, SMEs can potentially reduce operating costs while improving environmental performance. Resource efficiency is particularly important for SMEs because reducing material and energy losses can provide direct financial benefits.

Reverse logistics capability is central to the implementation of circular supply chains. It involves the systematic collection, transportation, inspection, sorting, storage, and processing of returned products and materials. SMEs need suitable mechanisms for collecting used products from customers and determining whether they should be reused, repaired, refurbished, remanufactured, or recycled. Efficient reverse logistics can transform end-of-life products into valuable secondary resources and reduce dependence on virgin materials. However, developing this capability may require collaboration with logistics providers, recycling firms, retailers, and customers [13].

Another important capability is resource recovery and closed-loop integration. SMEs need technical and organizational knowledge to recover components and materials and reintegrate

them into production systems. Remanufacturing can allow firms to restore used products to functional conditions, while recycling can recover materials for subsequent manufacturing processes. Effective closed-loop integration requires appropriate quality standards, recovery technologies, information systems, and production planning mechanisms. The ability to integrate recovered materials without compromising product quality is therefore a significant organizational capability.

Supplier and stakeholder collaboration capability is also essential because circular supply chains involve multiple actors. SMEs can collaborate with suppliers to develop sustainable materials, with customers to establish take-back programs, and with recycling or remanufacturing partners to recover products. Information sharing and joint problem-solving can reduce uncertainty and improve the coordination of circular activities. Such relationships can compensate for SMEs' limited internal resources by providing access to external expertise, infrastructure, technology, and knowledge [14].

Digital and technological capability further strengthens circular supply chain management. IoT sensors can track products and assets, blockchain can support traceability, artificial intelligence can improve demand and return forecasting, and data analytics can optimize inventory and reverse logistics. Digital platforms can connect manufacturers with suppliers, customers, recyclers, and other stakeholders, thereby improving information visibility.

4. ORGANIZATIONAL RESILIENCE AND ITS ROLE IN MANUFACTURING SMEs

Organizational resilience has become an important strategic capability for manufacturing SMEs because these enterprises operate in business environments characterized by supply disruptions, market uncertainty, resource constraints, technological changes, environmental pressures, and increasing competition. Organizational resilience broadly refers to the ability of an organization to anticipate potential disruptions, absorb their immediate effects, adapt its operations, and recover while maintaining essential functions and performance. Rather than viewing resilience only as the ability to return to a previous state after a disruption, contemporary research increasingly considers it an organization's capacity to adapt, transform, and develop new capabilities in response to changing circumstances [15].

For manufacturing SMEs, resilience is particularly important because they generally possess fewer financial, technological, and human resources than large organizations. A disruption affecting suppliers, transportation, production facilities, workforce availability, or customer demand can therefore have a disproportionately large effect on SME operations. Limited supplier diversification and dependence on a small number of customers or critical resources can further increase vulnerability. Developing organizational resilience enables SMEs to identify emerging risks, prepare contingency strategies, reorganize resources, and maintain operational continuity during uncertain conditions [16].

A major dimension of organizational resilience is anticipatory capability, which involves identifying potential threats before they significantly affect organizational performance. Manufacturing SMEs can strengthen this capability through environmental scanning, supply chain monitoring, risk assessment, demand forecasting, and scenario planning. Early

identification of material shortages, supplier instability, market fluctuations, or regulatory changes provides managers with additional time to develop alternative responses. Consequently, resilience begins before a disruption occurs and depends substantially on organizational preparedness and risk-awareness mechanisms [17].

Another important dimension is absorptive capacity, which represents the ability of an organization to withstand disruptions without experiencing severe deterioration in its core operations. Financial reserves, flexible production systems, inventory buffers, multiple suppliers, skilled employees, and reliable information systems can improve the capacity of SMEs to absorb unexpected shocks. However, excessive buffers may increase costs, making it important for SMEs to establish an appropriate balance between operational efficiency and resilience. Flexible resource allocation can allow firms to respond to disruptions while maintaining acceptable levels of productivity and service quality [18].

Adaptive capability is equally important because disruptions frequently require organizations to modify existing processes rather than simply restore previous operations. Manufacturing SMEs may need to change suppliers, redesign products, modify production schedules, introduce digital technologies, or develop alternative distribution channels. Organizational learning, employee flexibility, managerial decision-making, and innovation capabilities can facilitate these adaptations. Firms that learn from previous disruptions are better positioned to develop improved routines and reduce their vulnerability to future events [19].

Resilience also depends strongly on collaboration and information sharing. SMEs can rarely develop all resilience resources internally; therefore, relationships with suppliers, customers, logistics providers, financial institutions, technology partners, and government agencies can provide access to knowledge and alternative resources. Effective communication and information sharing improve supply chain visibility and enable faster coordinated responses to disruptions. Collaborative relationships can also facilitate joint problem-solving and resource sharing during periods of uncertainty [20].

5. RELATIONSHIP BETWEEN CIRCULAR SUPPLY CHAIN CAPABILITIES AND ORGANIZATIONAL RESILIENCE

Circular supply chain capabilities and organizational resilience are increasingly interconnected because both concepts emphasize flexibility, resource optimization, collaboration, adaptation, and long-term value creation. Circular supply chain management focuses on maintaining the value of products and materials through reuse, repair, remanufacturing, recycling, and recovery, whereas organizational resilience focuses on an organization's ability to withstand, adapt to, and recover from disruptions. Their integration can provide manufacturing SMEs with a broader strategic approach for managing both environmental challenges and operational uncertainty [21].

One of the primary mechanisms linking circular capabilities with resilience is resource flexibility. Traditional linear supply chains can create strong dependence on virgin raw materials and specific suppliers. Circular supply chains provide opportunities to recover and reuse materials from returned products, production waste, and secondary markets. Access to recovered materials can reduce dependence on external sources and provide alternative

resource channels when conventional supplies become unavailable. Consequently, resource recovery and reuse can increase the flexibility of manufacturing SMEs during supply disruptions [22].

Reverse logistics and closed-loop supply chain capabilities can similarly contribute to organizational resilience. Efficient reverse logistics systems enable firms to collect used products, components, and materials and return them to appropriate recovery processes. During supply shortages, recovered components may provide alternative inputs for production. Moreover, reverse logistics creates additional information about product usage, customer behavior, and material availability. This information can support more responsive planning and improve an SME's ability to adapt its operations under uncertain conditions.

Supplier collaboration represents another important connection between circularity and resilience. Circular supply chains require close coordination with suppliers, customers, recyclers, logistics providers, and other stakeholders. Through collaborative relationships, SMEs can obtain information about material availability, develop alternative sourcing arrangements, and coordinate recovery activities. Strong supplier relationships can therefore increase supply chain visibility and reduce the time required to respond to disruptions [23]. Collaboration also allows SMEs to access external resources and knowledge that may compensate for their limited internal capabilities.

Digital technologies can further strengthen this relationship. IoT-based tracking, cloud platforms, blockchain, artificial intelligence, and data analytics can provide information about product locations, material flows, inventory conditions, and recovery opportunities. Greater supply chain visibility allows SMEs to identify disruptions earlier and make faster decisions. Digitalization can therefore act as an enabling capability that connects circular supply chain activities with organizational resilience by improving information availability, coordination, traceability, and responsiveness. Table 1 summarizes how circular supply chain management practices improve economic, environmental, social, operational efficiency, resilience, and overall sustainable business performance in manufacturing SMEs.

Table 1: Impact Of Circular Supply Chain Management On Sustainable Business Performance

CSCM Capability / Practice	Mechanism of Impact	Economic Performance	Environmental Performance	Social Performance	Contribution to Sustainable Business Performance	Key Challenges for SMEs
Circular Procurement	Selection of recyclable, reusable,	Reduces material and procurement	Reduces consumption of virgin	Encourages responsible	Improves cost efficiency while	Limited supplier availability, higher



	durable, and environmentally responsible materials and suppliers	ent costs over the long term; improves resource efficiency	materials and environmental impacts from sourcing	supplier practices and ethical sourcing	supporting sustainable sourcing	initial procurement costs, lack of supplier information
Eco-Design	Incorporates durability, repairability, modularity, recyclability, and disassembly into product design	Reduces lifecycle costs and creates opportunities for product differentiation	Reduces material consumption, waste, and product-related environmental impacts	Provides safer, durable, and more sustainable products for customers	Supports innovation and long-term product sustainability	Lack of technical expertise, design costs, limited R&D resources
Green Manufacturing	Integrates cleaner production, energy efficiency, waste reduction, and resource optimization	Reduces energy, material, water, and waste-management costs	Decreases emissions, waste generation, and resource consumption	Improves workplace conditions and environmental responsibility	Enhances operational efficiency and environmental sustainability simultaneously	Investment requirements, technological limitations, employee training
Resource Efficiency	Maximizes utilization of materials, energy, water, and production inputs	Reduces production costs and improves productivity	Minimizes resource depletion and production waste	Encourages responsible resource utilization	Strengthens both economic efficiency and environmental performance	Difficulty measuring resource flows and identifying inefficiencies

					nce	cies
Waste Minimization	Prevents waste at source through process optimization and material recovery	Reduces waste-disposal expenses and material losses	Lowers landfill waste, pollution, and environmental burden	Promotes cleaner workplaces and environmental awareness	Converts waste reduction into operational and environmental value	Lack of waste segregation systems and recovery infrastructure
Reverse Logistics	Collects used products, components, packaging, and materials from customers for recovery	Generates recovered-value streams and reduces dependence on new materials	Reduces disposal and increases product/material reuse	Creates opportunities for repair and recovery-related employment	Strengthens closed-loop supply chain performance	Transportation costs, collection complexity, uncertain product returns
Reuse	Extends product, component, or packaging life through repeated use	Reduces purchasing and manufacturing costs	Reduces material consumption and waste generation	Encourages responsible consumption	Improves product life-cycle sustainability	Product-quality concerns and customer acceptance
Repair and Refurbishment	Restores products or components to functional condition	Creates additional revenue streams and extends product value	Reduces demand for new products and associated resource use	Creates repair-related skills and employment	Supports resource conservation and service-based business models	Lack of repair infrastructure and skilled workers
Remanufacture	Recovers	Reduces	Significant	Supports	Enhances	Quality

uring	used products and restores them to predetermined quality standards	production costs and creates secondary-market opportunities	ly reduces material and energy requirements compared with new production	technical employment and skills development	resource productivity and circular value creation	assurance, reverse-flow management, customer perception
Recycling and Material Recovery	Extracts reusable materials from products and production waste	Reduces raw-material expenditure and creates recovered-material value	Reduces resource extraction and disposal	Supports recycling-sector employment	Strengthens material circularity and environmental performance	Limited recycling technology and inconsistent material quality

6. CONCLUSION

The review indicates that Circular Supply Chain Management (CSCM) empowers manufacturing SMEs to embrace sustainable business performance via resource efficiency, circular procurement, eco-design, reverse logistics, recycling, remanufacturing, digitalization, and stakeholder collaboration. In the existing literature, it is shown that these capabilities not only reduce the consumption of materials, waste, operational expenses, and environmental impacts but also support innovation, competitiveness, and organizational resilience. Resilience makes the SMEs more capable of anticipating, absorbing, and recovering from supply chain disruptions and thus increases the strategic importance of circular capabilities beyond ecological sustainability. Nonetheless, SMEs seem to face various barriers such as lack of funding, technological limitations, inadequate expertise, poor recovery infrastructure, and limited collaboration with stakeholders. Further studies are expected to develop an integrated framework connecting CSCM competences with organizational resilience and economic, environmental, and social outcomes. It is also necessary that more research focuses on digital technologies and techniques such as artificial intelligence, blockchain, circular business models, inter-sector collaboration, and countries under development.

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