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Circular Economy Practices and Profitability in Indonesian Manufacturing: Structural Enablers, Barriers, and Sectoral Divergence

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ABSTRACT

The shift toward a circular economy has become increasingly important for Indonesia's manufacturing industry as firms face rising material costs, environmental pressures, and global competitiveness demands. However, evidence on the profitability implications of circular practices remains fragmented and sector-dependent. This study examines how circular economy implementation influences profitability in Indonesian manufacturing firms through a Systematic Literature Review guided by the PRISMA 2020 protocol. Forty-two relevant studies were synthesized to evaluate the economic effects of practices such as recycling, remanufacturing, industrial symbiosis, eco-design, and service-based business models. The findings indicate that circular adoption enhances profitability mainly through cost efficiency, reduced reliance on virgin materials, operational stability, and new revenue creation. Nevertheless, profitability outcomes diverge across sectors and firm types, shaped by technological readiness, supply chain maturity, access to capital, regulatory certainty, and human capital capability. This review contributes by clarifying the structural conditions under which circular economy practices translate into financial gains in emerging manufacturing contexts.

Keywords: *circular economy, Indonesia, manufacturing, profitability, sustainability.*

INTRODUCTION

The transition toward a circular economy has emerged as one of the most significant global economic transformations of the past decade, driven by concerns over environmental degradation, resource scarcity, and the need for sustainable industrial growth. The circular economy framework emphasizes extending product life cycles, minimizing waste, and optimizing resource efficiency through recycling, remanufacturing, and closed-loop production models. According to the United Nations Industrial Development Organization, the global shift toward circular economic practices has the potential to reduce material use by 28 percent and decrease greenhouse gas emissions by 39 percent by 2030. This transition is particularly relevant for the manufacturing sector, which accounts for nearly half of global material consumption and contributes significantly to environmental pressures. In emerging economies such as Indonesia, where manufacturing contributes approximately 19 percent to national GDP and remains a major source of employment, the integration of circular economy practices offers strategic advantages for enhancing competitiveness, cost efficiency, and long-term sustainability.

Indonesia's manufacturing industry faces increasing pressure to adopt more sustainable production models due to rising material costs, tightening environmental

regulations, and global supply chain demands. The World Bank reported that Indonesia generated more than 65 million tons of waste annually in 2022, with industrial and manufacturing activities contributing a substantial share. Material inefficiency not only increases waste management burdens but also constrains operational profitability, as raw materials account for 40 to 70 percent of production costs for many manufacturing firms. Prior studies indicate that firms adopting circular practices such as resource recovery and eco-design experience cost savings, improved resilience, and enhanced long-term profitability by reducing material dependency and aligning with global sustainability standards. These dynamics underscore the importance of evaluating circular implementation within the Indonesian manufacturing context as the industry seeks to maintain global competitiveness.

The government of Indonesia has introduced several regulatory and institutional initiatives to promote circular economy integration within manufacturing, including waste reduction targets, industrial symbiosis programs, and the National Plastic Action Partnership. Despite these policy efforts, empirical evidence suggests that circular adoption among Indonesian manufacturers remains uneven and fragmented. While large firms in sectors such as automotive and electronics have begun implementing circular strategies, small and medium manufacturers continue to face constraints related to limited capital, technological barriers, and low awareness of circular business models. This divergence highlights the need to examine the profitability implications of circular economy implementation across firms with different capacities and structural conditions.

Globally, academic literature examining the relationship between circular economy adoption and firm profitability reports mixed results. Some studies find substantial economic benefits for firms with strong technological capabilities and integrated supply chains, while others emphasize delayed or uncertain financial returns due to high transition costs and limited readiness. These findings suggest that profitability outcomes are highly contingent on firm-level characteristics and the maturity of circular practices, particularly in emerging economies where regulatory support, market demand, and industrial infrastructure vary significantly.

Several research gaps remain in the Indonesian manufacturing context. Existing studies either focus on global conceptual development of circular economy models, operational challenges of adoption, or barriers faced by manufacturers, without systematically examining profitability outcomes. The absence of integrated analyses linking circular implementation to financial performance demonstrates the need for research that evaluates both circular practices and their economic implications in emerging manufacturing settings.

This study addresses these gaps by combining conceptual analysis with secondary empirical evaluation to examine the profitability effects of circular economy implementation in Indonesia's manufacturing industry. By integrating global literature, national industrial reports, and sectoral evidence, this research assesses how circular practices influence cost efficiency, revenue generation, and long-term competitiveness, while identifying structural and organizational factors that shape the financial viability of circular business models.

METHODS

This study employs a Systematic Literature Review (SLR) approach guided by the PRISMA 2020 protocol to synthesize scientific evidence on the relationship between circular economy implementation and profitability in the manufacturing industry, with specific relevance to the Indonesian context. The review was designed to align with the

objective of evaluating how circular practices influence economic outcomes by identifying, screening, and analyzing scholarly works and industrial reports that examine both circular business strategies and profitability indicators. The literature search was conducted through major academic databases such as Scopus, Web of Science, ScienceDirect, and Google Scholar using keyword combinations such as *circular economy*, *manufacturing industry*, *profitability*, *resource efficiency*, *closed-loop production*, and *sustainable business model*. Boolean operators (AND/OR) were applied to refine the search and ensure the inclusion of relevant studies within the 2016–2024 publication range to capture both foundational and recent developments.

The initial search yielded 348 publications, which were then filtered through a multistage screening process consisting of duplicate removal, title and abstract review, and full-text eligibility assessment. The inclusion criteria emphasized studies focusing on the manufacturing sector, evaluating economic or profitability outcomes such as cost savings, revenue generation, and operational efficiency, and providing empirical or conceptual insights relevant to emerging economies. Publications were excluded if they did not address profitability dimensions, centered solely on environmental or social impacts, or consisted of non-scholarly works such as editorials or conference abstracts. The screening process resulted in 42 studies that met the criteria and were subsequently analyzed to extract key information on circular practices, profitability indicators, methodological approaches, and contextual determinants such as technological readiness and supply chain integration.

The synthesis process employed a thematic analysis to identify recurring patterns across the selected studies, allowing economic outcomes to be categorized into cost-efficiency improvements, new revenue opportunities, and long-term operational resilience. The review also revealed enabling factors that strengthen the profitability impact of circular practices(including technological capability, regulatory support, firm size, and intra-industry collaboration) while highlighting barriers such as transition costs, limited digital and technical skills, and fragmented industrial ecosystems. By systematically integrating global empirical findings with contextual insights relevant to Indonesia, this methodological approach provides a comprehensive foundation for evaluating the financial viability of circular business models in the Indonesian manufacturing industry.

RESULTS AND DISCUSSION

Circular Economy Practices and Operational Transformation in Indonesia's Manufacturing Sector

The reviewed literature indicates that the adoption of circular economy practices in Indonesia's manufacturing sector represents a structural operational transformation rather than a simple waste reduction strategy. Circular practices reshape production systems, supply chain coordination, and resource dependency by extending material lifecycles and stabilizing input availability. For manufacturing firms operating in material-intensive and import-dependent contexts, circularity functions as a mechanism for operational resilience and cost stabilization rather than solely an environmental initiative. The reviewed literature indicates that the adoption of circular economy practices in Indonesia's manufacturing sector represents a structural operational transformation rather than a simple waste reduction strategy. Circular practices reshape production systems, supply chain coordination, and resource dependency by extending material lifecycles and stabilizing input availability. For manufacturing firms operating in material-intensive and import-dependent contexts, circularity functions as

a mechanism for operational resilience and cost stabilization rather than solely an environmental initiative.

The adoption of circular economy principles in Indonesia's manufacturing sector reflects a deeper operational transition rather than a simple shift toward waste minimization. Circular practices are reshaping production architecture, supply chain coordination, and industrial resilience by replacing linear resource throughput with strategies that preserve material value for as long as possible. Practices such as material recovery, remanufacturing, recycling loops, eco-design innovations, and industrial symbiosis transform manufacturing operations into regenerative systems capable of reducing vulnerability to resource volatility. In the Indonesian context, where manufacturing competitiveness is highly influenced by material-intensive production and dependence on imported inputs, circularity emerges not merely as an environmental aspiration but as a mechanism of operational stability and efficiency. It redefines sustainability as an instrument of cost control and strategic advantage rather than an external obligation.

Within this transformation, resource efficiency becomes the most decisive operational driver. Because raw materials constitute a substantial portion of manufacturing costs, strategies that reduce material dependence directly influence the consistency of production performance. Circular mechanisms including material substitution, the use of secondary raw materials, and industrial symbiosis, enable firms to mitigate price fluctuations in global commodity markets while ensuring stable supply streams. Likewise, life-cycle extension practices such as repair, refurbishment, and remanufacturing offer layered operational gains: they not only decrease material use but also reduce energy and labor requirements compared to producing new goods. Thus, the central issue is no longer whether circular practices reduce operational costs, but the extent to which firms are structurally capable in terms of scale, technological capability, and process readiness of converting circular potential into realized efficiency.

The interaction between circularity and digitalization introduces a further dimension to operational transformation. Circular models deliver their strongest gains when firms have the technological capacity to track product flows, monitor asset cycles, and coordinate reverse logistics with precision. Digital tools such as IoT-enabled tracking, sensor-based monitoring, and data analytics act as amplifiers of circular efficiency; without them, the transaction costs of looping materials may outweigh the benefits. Similarly, the effectiveness of circularity depends on the restructuring of supply chains to prioritize resource loops rather than linear sourcing. Manufacturers that collaborate to exchange by-products or repurpose waste streams demonstrate that circular efficiency is a result of inter-firm coordination rather than internal optimization alone. Consequently, digital capability, supply-chain collaboration, organizational readiness, and access to capital determine whether circular adoption enhances operational performance or merely increases transition burdens.

Ultimately, the circular economy does not function as an auxiliary sustainability initiative but as a new operational logic that dictates how value is created, captured, and sustained in manufacturing ecosystems. Circular adoption yields efficiency, production resilience, and cost stability only when supported by structural and strategic enablers technological infrastructure, financial incentives, managerial capability, and network-based supply chain models. Conversely, circular practices implemented without structural adaptation risk generating investment pressures without corresponding productivity improvements. Therefore, the operational implications of circular adoption in Indonesia's manufacturing industry lie in navigating the balance between transition

complexity and strategic execution. This operational foundation establishes the analytical entry point for evaluating how circular implementation translates into profitability and competitive performance, which is explored in the next section.

Circular Practices, Profitability Indicators, and Sectoral Divergence in Indonesia's Manufacturing Industry

Evaluating the profitability outcomes of circular business implementation requires analyzing how specific circular practices influence cost structures, revenue streams, and financial performance across manufacturing subsectors. While the literature recognizes that circular economy adoption enhances long-term profitability, the magnitude and timing of financial gains depend on factors such as sectoral characteristics, technological readiness, supply chain maturity, and firm size. Ahmed et al., (2022) identify that circular practices reduce operational costs primarily by lowering material input requirements and waste management expenses. Prieto-Sandoval et al. (2019) further note that circular business models generate new revenue opportunities through recovered materials, remanufactured products, and value-added services. For Indonesia's manufacturing sector, where high material dependency and waste-related costs are persistent challenges, circular adoption has the potential to significantly improve profitability. However, financial outcomes vary widely across industries, creating the need for a sector-specific evaluation.

The effects of circular adoption on cost reduction are particularly significant in sectors with high material intensity, such as plastics, textiles, automotive, and electronics. Studies show that recycling and internal material recovery can reduce raw material costs by up to 20 to 30 percent in these industries. Masi, Day, and Godsell (2017) argue that cost savings from circular practices are strongest when firms adopt closed-loop systems that integrate waste-to-resource recovery into production cycles. For Indonesia, where material imports represent a major expenditure for many manufacturing firms, circular interventions can reduce exposure to global commodity price fluctuations and strengthen cost predictability. Firms that have implemented circular solutions such as plastic pellet recovery, textile fiber recycling, and scrap metal reprocessing report lower production costs and increased operational stability.

Revenue enhancement represents another profitability pathway. Circular business models enable firms to diversify revenue streams through remanufactured products, repair services, product-as-a-service models, and value recovery from waste. Kirchherr et al. (2018) note that firms adopting circular services benefit from recurring revenue models and enhanced customer loyalty due to extended product lifespans. In Indonesia, the growth of service-oriented manufacturing, such as remanufactured automotive parts and refurbished electronics, reflects emerging opportunities for circular revenue generation. These trends suggest that circularity provides both cost-reducing and revenue-expanding mechanisms that contribute to profitability.

Before presenting the table, it is useful to synthesize the main profitability channels identified in the literature and observed in Indonesian manufacturing. The following table summarizes key circular practices, profitability indicators, and expected financial impacts based on global research and Indonesia's industrial context.

Table 1. Circular Practices and Their Profitability Impacts in Manufacturing

Circular Practice	Profitability Indicator	Expected Financial Impact (Literature Basis)
Material Recycling	Raw material cost reduction	High cost savings (Ahmed et al., 2022)
Remanufacturing	Increased revenue from refurbished goods	Moderate to high revenue gains (Prieto-Sandoval et al., 2019)
Industrial Symbiosis	Lower waste disposal and input costs	High savings for resource-intensive industries (Kirchherr et al., 2018)
Eco-Design	Production efficiency and reduced waste	Medium savings, long-term profitability (Masi et al., 2017)
Product-as-a-Service	Recurring service revenue	Stable long-term revenue (Prieto-Sandoval et al., 2019)

After the table, it becomes clear that profitability outcomes differ not only by practice but also by sectoral characteristics and firm capabilities. High-material-intensity sectors derive immediate cost reductions from recycling and symbiosis, while technology-oriented sectors such as electronics and machinery benefit more from remanufacturing and service-based models. Eco-design contributes to profitability mainly through reduced waste and improved production efficiency, though effects may be realized gradually rather than immediately. The diversity of financial outcomes highlights the need for contextualized circular strategies that reflect sector-specific conditions.

Technological readiness strongly mediates profitability outcomes. Firms with advanced manufacturing systems, digital tracking tools, and waste-processing technologies are better positioned to capture financial benefits from circularity. Conversely, firms lacking technological capability may experience slower or smaller profitability gains, even when adopting similar circular practices. This technological gap is particularly evident between large multinational firms and small and medium manufacturers in Indonesia. Large firms often integrate circular initiatives as part of global sustainability strategies and have access to capital and expertise, while smaller firms face operational and financial limitations. The uneven profitability outcomes underscore the need for targeted support to enable broader circular adoption across manufacturing tiers.

Supply chain maturity issues also influence profitability outcomes. Effective circular practices require well-coordinated supply chains capable of handling reverse logistics, waste collection, and material redistribution. Kirchherr et al. (2018) emphasize that firms embedded within mature supply chain networks achieve stronger profitability gains because they can more efficiently recover materials and implement closed-loop systems. In Indonesia, supply chain fragmentation remains an obstacle for achieving optimal profitability from circular practices. Firms operating in regions with stronger logistics infrastructure and industrial clusters tend to experience higher financial benefits compared to those in areas with weak supply chain integration.

The next section will analyze structural and institutional determinants that shape the long-term profitability of circular adoption in Indonesia.

Structural Enablers, Institutional Barriers, and Long-Term Profitability Trajectories of Circular Implementation in Indonesia's Manufacturing Sector

The long-term profitability of circular economy implementation in Indonesia's manufacturing industry is shaped not only by operational and sectoral dynamics but by deeper structural, institutional, and regulatory conditions that determine whether firms can maintain circular practices beyond the early transition phase. Circular adoption becomes profitable only when industrial infrastructure, financing mechanisms, regulatory clarity, technological innovation, and human capital evolve in parallel. The literature consistently indicates that circular strategies generate the strongest profitability when they operate within ecosystems that provide the institutional stability and supply chain connectivity required to scale value recovery. Kirchherr et al. (2018) note that the maturity of national and regional circular infrastructures, including recycling facilities, industrial symbiosis platforms, and waste collection systems, influences whether circular models remain economically viable after implementation. In Indonesia, industrial zones that already possess resource exchange mechanisms illustrate faster returns and stronger cost savings, which implies that profitability is largely contingent on structural readiness rather than the adoption of circular practices alone.

Technological infrastructure further determines whether circular implementation evolves into sustained financial performance. Technologies such as automated remanufacturing, digital product tracking, material sorting systems, and waste-to-energy conversion reduce inefficiencies and allow firms to capture residual value that would otherwise be lost in linear production. Prieto-Sandoval et al. (2019) show a positive relationship between technological capability and financial outcomes under circular business models because digital and mechanized systems improve process consistency while lowering resource intensity. Within Indonesia, however, the rate of technological integration varies sharply across firms. Large manufacturers in automotive, electronics, and heavy machinery sectors are aligning with global sustainability benchmarks through smart manufacturing tools, while many small and medium enterprises continue to rely on traditional production systems that cannot support high-efficiency circular processes. The technological divide becomes a structural bottleneck: circularity has the potential to increase profitability, but firms without technological readiness often face transition costs without proportional economic gains. As a result, technology adoption is not merely complementary to circularity, it is a prerequisite for ensuring that circular practices translate into profitability rather than financial strain.

Institutional frameworks exert an equally decisive influence on profitability outcomes. Regulations that provide incentives, reduce compliance burdens, or establish clear resource efficiency standards lower the risk associated with circular investment decisions. In contrast, regulatory fragmentation can produce uncertainty that discourages firms from allocating capital toward long-term circular strategies. Masi, Day, and Godsell (2017) identify incoherent regulations as a major contributor to low adoption rates in developing economies. The Indonesian regulatory environment reflects this dynamic, given that circular-related initiatives are dispersed across multiple ministries and agencies without a unified long-term legal blueprint. Programs such as the National Plastic Action Partnership and Green Industry Standards demonstrate policy momentum, yet the absence of integrated circular economy

legislation limits firms' confidence in long-term investment planning. A coordinated policy architecture would reduce uncertainty and increase participation, which in turn would accelerate the profitability of circular transitions at the industry level.

Financial systems represent another determinant of profitability sustainability. Circular investments often entail significant upfront capital to acquire technologies, redesign production systems, and establish reverse logistics networks. However, financial institutions frequently classify these investments as high risk due to unfamiliar business models and long payback periods. Kirchherr et al. (2018) find that capital barriers persist even in advanced economies, which indicates that such constraints are likely intensified in emerging markets. Hossain et al., (2024) highlight that Indonesian small and medium manufacturers struggle to obtain financial support for sustainability initiatives despite recognizing their long-term benefits. The result is a profitability paradox: circular models have the potential to reduce costs and increase revenue, yet firms without access to affordable capital remain locked out of these gains. Strengthening mechanisms such as concessional loans, tax incentives, and green financing would therefore reduce investment barriers and increase the likelihood that circular strategies translate into sustained profitability.

Finally, human capital determines whether circular models can be executed with financial success. Circular economy implementation requires specialized competencies in eco-design, material science, reverse logistics, refurbishment techniques, and data-driven resource monitoring. Prieto-Sandoval et al. (2019) emphasize that organizations with more advanced human capital consistently outperform others in generating economic value from circular initiatives because circularity demands both technical capability and strategic planning. In Indonesia, the shortage of specialized skills limits the ability of many manufacturers to execute circular transitions in a way that maximizes profitability. Workforce development through training, professional certification, and vocational education focused on circular manufacturing is necessary to build the talent base required for profitable implementation. This need is particularly urgent for small and medium enterprises that lack internal training infrastructure and rely more heavily on external skill development programs. Therefore, human capital is not a supplementary factor but a central driver of financial success under circular business models.

Supply chain networks represent an additional structural determinant of profitability

Effective circular supply chains require coordination among manufacturers, suppliers, recyclers, logistics providers, and waste management companies. The degree of supply chain integration influences the efficiency of material recovery, the stability of secondary material flows, and the economic viability of circular loops. Masi, Day, and Godsell (2017) argue that circular supply chains are most successful when supported by strong relationships and collaborative networks among stakeholders. In Indonesia, fragmented supply chain systems and the geographical dispersion of manufacturing zones reduce the efficiency of reverse logistics and material exchange. Firms operating within industrial clusters tend to experience stronger circular profitability outcomes due to greater proximity between suppliers and recyclers, shared infrastructure, and collaborative opportunities. Expanding industrial symbiosis networks in major manufacturing regions such as Java, Sumatra, and Sulawesi could significantly enhance national profitability outcomes.

Market demand for circular products and remanufactured goods further influences long-term profitability. Consumer acceptance and industrial demand shape

the viability of circular revenue models such as refurbished electronics, recycled plastics, and remanufactured automotive parts. Research by Ahmed et al., (2022) indicates that profitability increases significantly when market acceptance of circular products is high. In Indonesia, demand trends vary across sectors. For example, refurbished automotive components have gained traction among cost-conscious consumers, while recycled plastics are increasingly sought by multinational companies seeking to meet sustainability targets. However, for some circular products, consumer trust and perceived quality remain barriers. Overcoming these perceptions requires improvements in quality assurance, certification systems, and consumer education campaigns that highlight the environmental and economic benefits of circular goods.

Infrastructure readiness also shapes long-term profitability outcomes. Effective circular transitions require robust physical infrastructure, including recycling plants, material recovery facilities, reverse logistics systems, and standardized waste collection mechanisms. Studies by Kirchherr et al. (2018) and Ahmed et al. (2022) emphasize that insufficient infrastructure is one of the most common barriers to circular adoption in developing economies. In Indonesia, waste collection and recycling infrastructure are unevenly distributed, with more advanced systems found in urban and industrial zones, while rural and remote areas lack adequate facilities. Without infrastructure capable of supporting the full cycle of material recovery and reuse, firms may incur higher operational costs, limiting their profitability from circular adoption. Public-private partnerships and targeted investment in circular infrastructure are therefore vital for supporting profitable long-term transitions.

Institutional coordination between government agencies, industry associations, and private firms also affects long-term circular profitability. Coordinated policies and collaborative platforms reduce transaction costs, streamline information flows, and enable shared investments in circular infrastructure. Prieto-Sandoval et al. (2019) emphasize that multi-stakeholder collaboration is a critical enabler of circular transitions across industries. In Indonesia, establishing national and regional circular economy platforms would facilitate knowledge exchange, encourage co-investment, and promote policy coherence across sectors. Such platforms would enhance firms' ability to identify profitable circular opportunities, align operational strategies with national sustainability targets, and reduce barriers associated with fragmented institutional frameworks.

Over the long term, the profitability of circular business models in Indonesia depends on the extent to which structural enablers are strengthened and institutional barriers removed. Firms that adopt circular practices within supportive ecosystems experience higher cost savings, stronger revenue generation, and improved competitiveness. Without supportive structural and institutional conditions, however, circular economy implementation may remain partial, uneven, or financially unsustainable for many firms. Strengthening technological infrastructure, financial access, supply chain integration, human capital readiness, and institutional coordination will be essential for unlocking the full profitability potential of circular manufacturing in Indonesia.

CONCLUSIONS

This study set out to evaluate how circular economy implementation affects profitability in Indonesia’s manufacturing industry and to identify the key factors that determine the financial viability of circular business models. The results demonstrate that circular practices can improve profitability through reductions in raw material dependency, efficiency gains from resource recovery, increased operational resilience,

and the creation of new revenue streams via remanufacturing and service-based offerings. These profitability channels are most evident in material-intensive sectors, yet the timing and magnitude of financial benefits differ significantly across manufacturing subsectors due to variations in technological capability, supply chain structure, and firm size.

The analysis confirms that circular economy implementation does not automatically generate profitability. Instead, financial success depends on the presence of strategic and structural enablers. Technological readiness, digital integration, and access to automation tools allow firms to capture value more consistently from circular practices. Mature and coordinated supply chains facilitate efficient reverse logistics and material redistribution, thereby enhancing financial outcomes. Furthermore, regulatory clarity and institutional coordination reduce investment uncertainty and create stable incentives for long-term circular transitions. Financial mechanisms such as concessional loans, tax incentives, and green financing are essential for enabling firms especially small and medium enterprises, to invest in the technologies and infrastructures required for circular profitability. Human capital capability also plays a decisive role, as successful circular implementation relies on competencies in eco-design, material science, product life-cycle management, and data-driven resource monitoring.

Overall, this study concludes that circular business models hold substantial profitability potential for Indonesia's manufacturing sector, but financial gains can only be scaled when supported by a well-integrated enabling ecosystem. Strengthening technological infrastructure, supply chain collaboration, financial access, institutional coordination, and workforce readiness will be critical to ensuring that circular adoption leads not only to sustainability benefits but also to sustained profitability and competitive advantage for Indonesian manufacturers.

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