APTISI Transactions on Technopreneurship (ATT)
Vol. 8, No. 2, July 2026, pp. 420−433
E-ISSN: 2656-8888 | P-ISSN: 2655-8807, DOI:10.34306

Visualizing the Adoption of Circular Economy Practices in Emerging Apparel Industry through Rich Picture

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Article Info

Article history:

Submission October 12, 2025
Revised November 2, 2025
Accepted January 26, 2026
Published April 1, 2026

Keywords:

Collaborative Governance
Entrepreneurship
Stakeholder Interaction
Soft System Methodology
Sustainable Production

ABSTRACT

The study aimed to visualize and understand how circular economy practices had been adopted within emerging apparel industry by employing the Soft Systems Methodology (SSM) through Rich Picture analysis. **Qualitative data** were collected from interviews, focus group discussions, and policy document reviews. **The study explored** interactions among key stakeholders within the apparel industry ecosystem, which consisted of government institutions, apparel producers ranging from large brands to Small and Medium Enterprises (SMEs), associations, recyclers, and consumers. The analysis applied SSM through Rich Picture to visualize technological readiness, entrepreneurial innovation, stakeholder relationships, and socio-political dynamics that shape the adoption process. **The finding revealed** that the adoption of circular practices was still at an early and fragmented stage. Limited technological capacity, weak policy coordination, and unequal power relations between dominant brands and smaller producers created significant barriers to progress. Several emerging initiatives led by ethical brands and community-based recyclers demonstrated a growing entrepreneurial creativity and moral commitment toward sustainable production. The Rich Picture captured these dynamics visually, connecting technological constraints, regulatory gaps, and market perception that influenced the system's current state. **This study concluded** that accelerating circular adoption required systemic collaboration among entrepreneurs, policymakers, and technology actors. By extending SSM to the context of sustainability-driven innovation, this research provided practical insights for policymakers and industry practitioners to strengthen technological capacity, financial incentives, and partnership mechanism in building a more circular and inclusive apparel ecosystem.

DOI: https://doi.org/10.34306/att.v8i2.874

1. INTRODUCTION

The apparel industry constitutes one most resource intensive manufacturing sectors worldwide and significantly contributes to pollution, water consumption, and waste generation [1–3]. The global apparel system still operates under a linear take-make-dispose model that depends heavily on virgin materials and cheap labour, which undermines sustainability and circularity targets [4–6]. Recent estimates suggest that the industry is responsible for around 10% of global carbon emissions and uses approximately 79 trillion litres of water each year [1–3]. The circular economy framework promotes value retention through product

life extension, material reuse, and waste recovery, thereby decoupling economic growth from environmental degradation [7–9]. Numerous studies have explored circular business models and consumer behaviour in the apparel focus on Global North [10], [11], while Asia, despite being the main textile hub and growing market, remain underexplored [3]. Implementing circular in this context requires new organizational capabilities and alignment across networks to create shared sustainability value [12], [13].

In contrast, research on the circular economy in emerging country remains limited and fragmented. Studies have shown that firms, especially SMEs, face multiple sociocultural, economic, and institutional challenges that hinder circular transition [11], [14]. Financial barriers such as limited access to credit and high implementation cost often restrict innovation in these context [14]. Institutional weaknesses continue to hinder the development of circular practices in emerging economies [14]. Government gaps, excessive regulation, and a weak policy environment further constraint progress, limiting the ability the firms to implement systemic circular initiatives [14], [15]. Limited technological capability and reliance on informal waste management markets also slow the pace of circular adoption and reduce systemic integration [11], [15].

Recent studies in Indonesia's circular apparel sector have begun to explore both the behavioural and managerial aspects of sustainable consumption and business model innovation [16, 17]. The studies reveal that consumer awareness and perceived value influence ethical purchase intention, while small enterprises face structural constraints in adopting circular practices [18]. Existing research on circular economy adoption predominantly focuses on firm or consumer level analysis [19]. It offering fragmented insights that overlook multi stakeholder dynamic and the need for systemic frameworks to explain circular adoption across systems levels [20, 21].

The study employed empirical data collected from Indonesia's apparel industry, which exemplifies the characteristics of an emerging ecosystem marked by institutional fragmentation and stakeholder asymmetry [22]. The sector is deeply embedded within global production networks that link domestic producers with international buyers, and its organizational structures are shaped by complex institutional contexts and regulation variations [23–25]. Such conditions provide a valuable empirical ground to examine how social political structures, policy alignment, and collective learning processes shape the adoption of circular practices [26]. By analysing this context through Soft System Methodology (SSM), the research aimed to capture the complexity of interactions among diverse actors that operate across formal and informal institutional boundaries [27, 28].

This study aimed to visualize the adoption of circular economy practices in emerging apparel industry ecosystems by using the SSM through Rich Picture analysis. The research sought to identify the socio-political structures, stakeholder relationships, and systemic barriers that influence the adoption of circular practices. The study contributes theoretically by extending the application of SSM into the circular business ecosystem discourse, and practically by providing systemic insights to guide collaborative governance and policy coherence in emerging economies.

2. LITERATURE REVIEW

The apparel industry is widely recognized as one of the most resource-intensive manufacturing sectors due to its dependence on virgin materials, intensive water and energy use, and short product life cycles [29]. The prevailing linear production model has contributed to significant environmental degradation and waste generation, prompting increasing attention to the circular economy as an alternative paradigm. In the apparel context, circular economy practices focus on resource efficiency, value retention, and closed-loop material flows through reuse, recycling, and product life extension [30]. Previous studies have explored circular business models, sustainable materials, and consumer behaviour in the fashion industry, showing that circularity has the potential to reduce environmental impacts while creating new forms of economic value. However, most empirical evidence remains concentrated in developed economies, while the adoption of circular practices in emerging countries is still limited and fragmented [31].

In emerging apparel ecosystems, circular economy implementation is shaped by complex interactions among multiple stakeholders and constrained by structural, institutional, and market-related barriers [32]. Prior research highlights that SMEs face limited access to finance, technological constraints, weak regulatory support, and fragmented governance structures, which hinder the scaling of circular initiatives beyond pilot projects [33]. Power asymmetries within apparel supply chains further restrict circular adoption, as large brands and manufacturers dominate decision making while smaller producers, recyclers, and informal actors remain marginalised [34]. Consumer perceptions also play a critical role, as recycled or upcycled apparel is of-

ten perceived as inferior, reducing market demand and discouraging investment in circular production. Despite growing recognition of these challenges, existing studies largely examine firm-level or consumer-level factors in isolation, offering limited insight into the systemic dynamics that shape circular economy adoption [35].

Therefore, a holistic and systemic approach such as SSM is required to capture the socio-political structures, stakeholder relationships, and interdependencies that influence circular transitions in emerging apparel industries. Unlike conventional system analysis tools widely used in sustainability research, such as Life Cycle Assessment (LCA), system dynamics modelling, or firm-level analytical frameworks, which primarily focus on material flows, environmental impacts, or organizational efficiency, SSM emphasizes problem situations that are socially constructed, politically contested, and institutionally fragmented. The Rich Picture technique further enables the visualization of informal interactions, power asymmetries, and value conflicts among diverse stakeholders that are often overlooked by quantitative or reductionist approaches [36]. This methodological distinction provides a novel lens for understanding circular economy adoption in emerging apparel ecosystems, where formal regulations coexist with informal practices and multi-actor negotiations shape sustainability outcomes [37]. By highlighting these complex interactions, SSM not only offers insights into the structural constraints and opportunities within the system but also paves the way for more inclusive and collaborative strategies to foster circular practices.

3. RESEARCH METHODS

3.1. Design Research

This study adopted a qualitative exploratory design based on SSM developed by Checkland [27]. The SSM framework served as a problem-solving approach [38, 39]. The procedure began with clarifying the unstructured problem situation and proceeded through data collection, reduction, and synthesis. The development of the Rich Picture was carried out in the second stage of SSM, the problem situation expressed phase [39]. Three layers of analysis were applied to structure the problem: the first identified the client, practitioner, and issue owner; the second examined roles, norms, and values; and the third investigated power relations and authority. The synthesis of these analyses produced a Rich Picture representing interactions among actors within Indonesia's apparel industry, followed by mapping each actor's primary tasks.

Primary data were collected between October 2024 and June 2025 through semi structured interviews, field observations, and document reviews. The participants represented twelve key stakeholders in the apparel ecosystem, including producers and brands, recycling and recovery actors, a government representative, and industry associations. To preserve confidentiality, institutional and brand names are not disclosed, and quotations are attributed only to general actor categories (e.g., industry practitioner, association representative, or policy level informant). Each interview lasted between 90 minutes and two hours and was recorded with participants consent. Document analysis included government policy papers. These documents were used to contextualize interview findings and to triangulate institutional narratives on circular economy adoption.

All interview transcripts we transcribed verbatim and analysed using content analysis to identify key patterns related to circular adoption. The analysis followed the first two stages of SSM, namely expressing the unstructured problem situation and developing the Rich Picture. An initial open-coding process was used to extract keywords and phrases concerning actor roles, norms, values, power, and authority. The codes were then grouped into thematic clusters representing institutional, social, and market dynamics. Thematic interconnections were visualized through a Rich Picture, which depicted feedback loops, stakeholders interdependencies, and systemic tensions. The Rich Picture framework can be adapted for digital modeling and policy simulations. It translates key actors, material flows, decision points, and institutional constraints into causal relationships for system dynamics or agent-based simulations. This allows policymakers and stakeholders to test the impacts of regulatory changes, investments, or incentives on circular economy adoption, making the Rich Picture both a diagnostic tool and a foundation for policy design.

Triangulation was conducted through the integration of multiple data sources and perspectives to enhance interpretive reliability. The researchers compared findings across interviews, policy documents, and field observations to validate consistency of emerging themes. In addition, key insights from the Rich Picture were reviewed with selected participant during informal feedback sessions to ensure that the visual representation accurately reflected the real-world relationships and tensions within the industry ecosystem.

4. RESULT AND DISCUSSION

4.1. Result

4.1.1. Stage 1. Problem Situation Expressed (SSM Stage 1)

The first stage of SSM explored the unstructured and complex conditions of Indonesia's apparel industry, a sector dominated by linear practices. Interviews and document analysis revealed seven major problem areas that hinder the transition towards circularity, including the absence of organized textile waste collection and sorting systems, limited recycling technology and inconsistent product quality, lack of economies of scale and unstable supply of recycled feedstock, high cost structure and weak price competitiveness, low market awareness and limited demand for circular products, institutional and regulatory gaps, and a shortage of technical experts and R&D capacity. These issues were repeatedly mentioned across government, industry, association, and recycler interviews.

- Absence of organized textile waste collection and sorting systems

  Textile waste management remained largely informal and fragmented. While several large factories collaborated with collectors to recycle production scraps, post-consumer garments lacked organized return or sorting schemes. Most second-hand textiles ended up in informal markets or landfills. A policy level informant noted that "factories usually collaborate with local collectors for pre consumer scraps, but the system is not standardized or supervised". Respondents explained that used clothes typically "end up with informal traders or in landfills". Many collectors were still legally registered as traders than recyclers, preventing them from entering formal waste management channels. This structural gap perpetuated fragmented and short-term initiatives, with circular activities operating outside industrial frameworks.

- Limited recycling technologies and product quality issues

  Technological limitations emerged as a major constraint. Several technical informants explained that mechanical recycling through open-end spinning remained the dominant method, but it could only produce coarse yarns with weak tensile strength. One practitioner remarked that "recycled yarn is usually thicker and less durable than virgin yarn". The growing use of blended fabric such as polyester and cotton further complicated recycling, as chemical separation technologies were scarce domestically. Consequently, recycling efforts often resulted in downcycling, producing rags or insulation instead of high value textiles.

- Lack of economies of scale and unstable feedstock supply

  Recycling plants required large, stable waste inputs to operate efficiently, yet fragmented supply chain made this difficult. "Recyclers depend on inconsistent volumes. Sometimes they even import sorted textile waste because local is unreliable", explained an association representative. Without centralized sorting hubs or cooperative networks, production cycles remained intermittent and economically unsustainable.

- High cost structure and weak price competitiveness

  Almost all industry participants described circular production as more expensive than conventional manufacturing. As one manufacturer summarized, "recycled fibre can cost twice as much as virgin material because sorting and cleaning are labour intensive". Without financial incentives, green financing, or fiscal support, the price differential discouraged widespread adoption. This situation kept circular production confined to small-scale or niche markets.

- Low market awareness and limited consumer demand

  Market actors emphasized that domestic consumers often perceive recycled apparel as inferior. A small business owner explained that "many still see recycled fabric as rough or unattractive". Due to this perception gap, most sustainable brands targeted international or high-end buyers rather than local markets. The absence of labelling, education, and promotional efforts further weakened consumer-driven demand for circular apparel.

- Institutional and regulatory fragmentation

  At the policy level, respondents highlighted overlapping mandates and the lack of a central coordinating agency. An association informant observed that "each ministry has its own target, but no one conducts the

orchestra for circular economy in textiles". Moreover, unclear business classifications for recyclers that registered under trade rather than waste management codes had restricted access to industrial incentives. These institutional silos reinforced policy inertia and limited implementation of pilot initiatives.

- Shortage of technical expertise and R&D capacity

  Finally, a recurring theme was the limited pool of experts in fibre recycling and product redesign for circularity. A technical respondent explained that "most factories still learn through trial and error", while another added that "we rely in foreign standards because local R&D is minimal". The lack of national knowledge infrastructure slowed innovation and deepened dependency on imported technology and expertise".

  Overall, stage 1 revealed an ecosystem marked by fragmented coordination, technological limitations, and economic disincentives. These interlinked issues illustrate the structural inertia that continues to anchor Indonesia's apparel industry within a linear paradigm, despite growing policy and market interest in circular transition.

4.1.2. Stage 1. Analysis One: The Intervention Itself

Analysis one in SSM identified the main elements of the intervention, which included who initiated it (clients), who conducted the inquiry (practitioners), and who owned the issues (issue owners). In this study, the intervention referred to the effort to understand and improve the conditions that had hindered circular adoption within the apparel ecosystem. This analysis clarified the systemic relationships among these roles and the boundaries of their concerns.

The clients were policy stakeholders at the national level who had formally recognized the study as relevant to the development of the circular economy roadmap for the textile sector. They acted as institutional sponsors who had sought diagnostic insights rather than direct problem solving. The practitioners were the research team who had carried out the data collection, interpretation, and visual representation through Rich Picture. They functioned as neutral facilitators who had connected perspectives from different actors without imposing predetermined solutions.

The issue owners were industry practitioners, SMEs, recycling actors, and association representatives who had directly faced operational, technological, and market challenges as identified in stage 1. For these stakeholders, circular adoption was not only a policy goal but also a significant managerial challenge. They encountered difficulties in integrating circular practices into daily operations due to limited resources, technological gaps, and inconsistent market demand. While they acknowledged the long-term benefits of circularity, the practical barriers they faced required both immediate and strategic adjustments to their business models.

Throughout the interviews, participants emphasized that interventions in the apparel industry had often been top down and project based. A policy informant mentioned that "many circular projects started as pilot projects but ended when funding stopped," while an industrial participant stated that "without continuous support, factories returned to their linear routines". This indicated that ownership of the problem had remained fragmented. Policy actors had controlled the strategic narrative, whereas operational actors had carried the burden of implementation. Therefore, the research was positioned as an enabling intervention that served as a systemic inquiry which had connected these fragmented perspectives and clarified who benefited, who decided, and who needed to act within Indonesia's circular transition landscape in the apparel industry. These relational findings provided the basis for the next analysis, which examined the social structure of the apparel ecosystem through the roles, norms, and values of its key actors.

4.1.3. Stage 1. Analysis Two: Social Snalysis (Roles, Norms, and Values)

Analysis two in the SSM explored the social dimension of the apparel ecosystem by examining the roles, norms, and values that shaped the behaviours of key actors. The findings showed that circular adoption had been influenced not only by technical and economic factors but also by deeply embedded social structures and shared expectations within the industry.

- Roles

  Each actors played a distinct yet interdependent role in sustaining or constraining circular practices. Policy actors at the national level had acted as regulators and facilitators who aimed to steer industrial transformation. An informant explained that the "government had focused on changing the industry's

mindset to see waste as a new source of raw materials". This role positioned policy institutions as drivers of formal initiatives, but their influence remained limited by weak interagency coordination.

Industrial associations represented the collective voice of producers, but their orientation had largely reflected the interests of large manufacturers. An association representative noted that "blended materials such as polyester and cotton had become dominant, but local recyclers had not been ready to separate them". This statement reflected the associations' concern for industrial efficiency rather than systemic sustainability.

At the operational level, firms and SMEs had served as experimenters and innovators. Some small circular apparel enterprises had sought to integrate ethical values, consumer education, and creative design into business practices. One SME practitioner stated that "circular production had not only been about profit but also teaching consumers to value materials".

Recyclers and waste collectors had played an important but marginal role. They had been responsible for material recovery but had operated outside formal systems. Their work had remained driven by pragmatic and subsistence values, as one respondent said, "we used everything we could, as long as it still had value".

- Norms and Values

  The social norms within the ecosystem reflected an imbalance between economic pragmatism and sustainability ethics. Policy actors had emphasized industrial competitiveness and efficiency. Industry associations had valued production stability and export performance. Meanwhile, SMEs and community innovators had promoted transparency, ethical production, and collaboration as alternative values. These differences illustrated a fragmented value system that had complicated the creation of shared meaning around circularity.

  As informant from the small industry sector described this contrast by saying that "large companies thought about efficiency, but we thought about impact". The findings revealed that moral and ethical values had existed but were not structurally supported by regulations or market incentives. As a result, symbolic and moral leadership emerged at the periphery rather than within mainstream industry governance.

  In summary, the social analysis revealed that the roles, norms, and values in the Indonesian apparel ecosystem had remained asymmetrical. Formal institutions and large producers had dominated decision making and resource control, while moral influence and innovation were driven by smaller actors. This imbalance reinforced the socio-structural constraints that hindered the diffusion of circular practices across the industry.

4.1.4. Stage 1. Analysis Three: Political Analysis (Power and Authority)

Analysis three examined the political dimension of the apparel ecosystem by identifying how power, and authority were distributed among key actors. The findings revealed that formal authority and actual influence had not always be aligned. Power was concentrated in government agencies and large manufacturers, whereas smaller actors, including recyclers and SMEs, exercised symbolic and moral influence rather than structural control.

- Formal power and institutional authority

  At the policy level, government institutions had possessed the highest formal authority. They had been responsible for developing regulations, allocating resources, and setting industrial priorities. A association informant mentioned that "each ministry had its own target, but none acted as the conductor for circular transition in textiles". This statement reflected institutional fragmentation, in which power was distributed but coordination remained weak. Despite holding the legal mandate, ministries lack unified leadership to integrate environmental and industrial objectives.

  Large manufacturers and brand owners had exercises significant economic power through their control over supply chains and purchasing decisions. One industry participant explained that "brand had thought carefully before using recycled materials because of cost and market uncertainty". This economic dominance allowed them to shape supplier behaviour and materials flow, which indirectly determine the direction of circular practices.

- Informal power and symbolic influence

  SMEs, community innovators, and recyclers had not held formal power but had influenced the discourse on sustainability through ethical narratives and cultural positioning. An SME representative stated that "our power was not in money but in message". Emphasizing that moral persuasion had often been more effective that regulation in raising awareness. However, without financial or institutional backing, this influence remained symbolic and limited in scope.

- Power dynamics and coordination challenges

  The coexistence of strong formal authority and weak coordination had created tension among actors. Policy agencies had controlled the agenda, but industrial execution depended on voluntary participation. Small innovators and recyclers had contributed local solutions but lacked access to decision making processes. Consequently, authority in the system had been hierarchical but influence had been fragmented.

  A practitioner summarized this imbalance by stating that "the government had the rules, but the industry had the market". The analysis indicated that while formal authority rested with policymakers, functional power lay with producers, and social legitimacy emerged from smaller moral actors. These three power layers had rarely converged, which limited the potential for collective action and slowed the circular adoption process.

  The social and political analysis clarified how roles, values, and power relations had shaped interactions within the apparel ecosystem. Table 1 presented the distribution of influence and authority among key actors.

Table 1. Social and Political Structure of The Apparel Ecosystem

Actor	Roles	Norms and Values	Power	Authority
Policy institutions	Regulated and facilitated industrial transition	Efficiency, competitiveness, and industrial growth	High structural power due to policy and budgetary control	Formal national authority over industrial direction
Large manufacturers and brands	Major producers and decision makers for materials and investments	Profitability, supply stability, selective for export	High economic power, strong market leverage	Market authority influencing suppliers and demand
Industry associations	Advocated member interests and industrial stability	Production efficiency, profitability, export continuity	Symbolic network power, mainly aligned with large firms	Representative authority in industrial policy forums
SMEs and circular apparel enterprises	Innovated small-scale circular models and promoted ethical apparel	Ethics, transparency, collaboration, and consumer education	Limited financial power, strong symbolic influence	Social authority through public engagement
Recyclers and Collectors	Collected, sorted, and repurposed textile waste	Pragmatism, survival-oriented values	Operational power at ground level; weak formal recognition	Informal authority within waste markets
Certification Bodies	Set and monitored sustainability standards	Transparency, compliance, international accountability	Normative influence through certification requirements	Technical authority recognized in global trade

Actor	Roles	Norms and Values	Power	Authority
Consumers	Determined demand for circular products	Low awareness, price, and trend-driven values	Weak market power due to limited awareness	Potential moral authority through purchasing behaviour
Community innovators and NGOs	Advocated ethical and sustainable practices	Social awareness, inclusivity, transparency	Growing social influence through campaigns	Non-formal authority shaping public opinion

4.1.5. Stage 2. Expressing the Problem Situation: Rich Picture and Primary Tasks (SSM Stage 2)

Figure 1 presented a Rich Picture that visualized the interactions among actors, material flows, and decision points shaping the adoption of circular practices in Indonesia's apparel ecosystem. The visual combined policy institutions, manufacturers, subcontractors, brands, retailers, consumers, collectors, recyclers, NGOs, universities, certification bodies, and financial actors within one systemic frame.

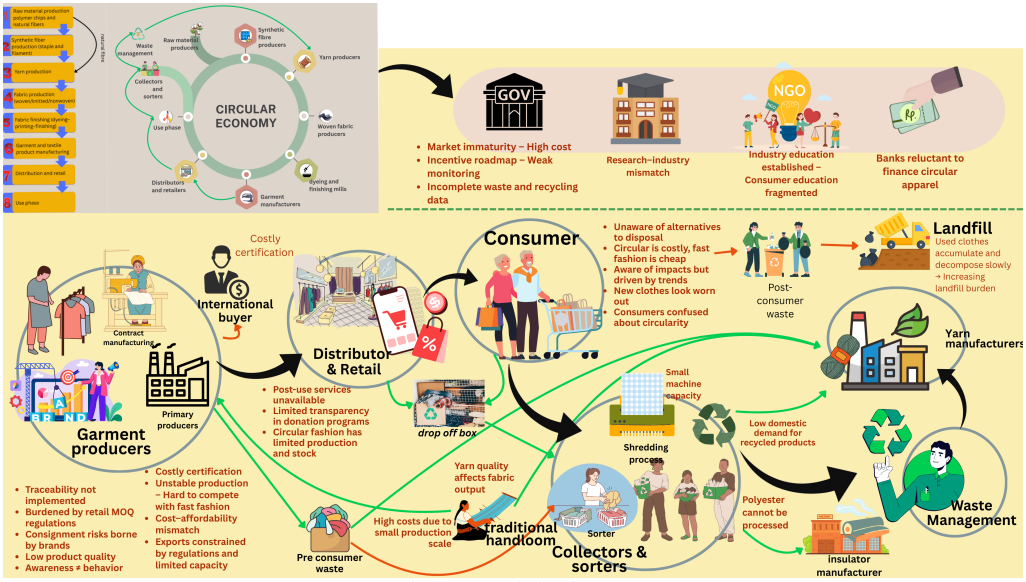

Figure 1. Rich Picture

The flows started from fibre and yarn producers, continued through garment production, distribution, and retail, then reached consumers and returned through take back, sorting, shredding, and recycling loops. Figure 1 showed that most loops had stopped at downcycling, constrained by limited sorting capacity, inconsistent product quality, and weak consumer demand. Annotations in the picture indicated three friction points, namely the lack of organized textile collection and sorting, the absence of cross agency coordination and monitoring at the policy layer, and the misalignment between the cost of recycled materials and market acceptance.

Interviews confirmed these patterns, with a manufacturing informant citing higher costs and variable quality delaying material transition, while a policy informant mentioned unclear coordination and scaling for pilot programs. A recycling actor described that sorting had depended on manual labour, producing mainly low value outputs. These perspectives matched the tensions illustrated in Figure 1, emphasizing the interlay between economic, institutional, and behavioural constraints.

The Rich Picture served as a descriptive synthesis, offering a shared reference to understand the system's current configuration and identifying key leverage points for further SSM stages. The identification of primary tasks complemented the visual analysis by clarifying each actor's operational focus within the circular ecosystem. This mapping described how different actors sustained the system through distinct functions and revealed which activities remained structurally constrained by economic, institutional, and behavioural constraints. The primary tasks are summarized in Table 2.

Table 2. The Primary Tasks

Actor	Core tasks and focus	Actor	Core tasks and focus
Policy bodies	Formulated national roadmap, coordinated pilot programs, and aligned industrial and environmental goals	Large manufacturers and brands	Ensured export compliance and quality standards; decided on materials and supplier engagement
Subcontract manufacturers	Completed cut, make, trim orders as specified by brand instructions, without autonomy over materials or design	Local circular brands and SME's	Developed upcycling or recycling models; collaborated with artisans and promoted consumer education
Retailers	Distributed product and hosted limited take, back or donation points; played an initial role in reverse logistics	Consumers	Made purchase decisions mainly based on price and trend; created limited demand for circular products
Collectors and recyclers	Aggregated and sorted textiles; converted waste into secondary materials within fragmented networks	Certification bodies	Verified traceability and compliance with standards such as GRS and RCS
Universities and research centres	Produced technical knowledge for material innovation; rarely linked outputs directly to industry needs	NGOs and communities	Promoted public awareness and social legitimacy for circular consumption
Financial actors	Evaluated regulatory risk and released capital selectively under clear policy signals	Industry associations	Connected firms to global initiatives and represented sectoral interests in policy dialogues

Together, Figure 1 and primary task mapping offered an operational snapshot of how the apparel industry's current structure constrained and enabled circular adoption. This diagnostic view served as the foundation for the subsequent stage of SSM analysis.

4.2. Discussion

The findings illustrated how Indonesia's apparel ecosystem remained locked in structural constraints that hinder truly circular transition. The Rich Picture revealed that material flows frequently broke at sorting and consumer acceptance stages, the institutional layer exhibited fragmentation, and power asymmetries made it difficult for smaller actors to influence decisions. Interpreted against the literature, several contributions and implications emerge.

The obstacle around textile collection and sorting aligns with prior work showing that reverse logistics infrastructure remains one of the slowest evolving nodes in textile CE systems. This is consistent with recent empirical findings highlighting persistent inefficiencies across collection and sorting activities within circular textile networks. These studies similarly reveal that textile collections systems are constrained by inadequate infrastructure, poor collection quality, and high logistical costs, with most sorting process still relying on manual operation and lacking digital or regionally integrated solutions to support efficient material flow [40–42].

The cost and quality constraints we documented echo findings from recent supply chain studies. Brands tend to adopt circular practices only when upstream suppliers can meet strict quality requirement,

otherwise such models remain peripheral. [23] similarly found that in Vietnam and Indonesia, conflicts of interest, information asymmetries, and unfair purchasing practices by global retailers foster mock compliance and opportunistic behaviour among suppliers. These patterns mirror the institutional and power asymmetries seen in Indonesia's apparel sector, when brand-driven compliance pressure coexists with weak governance and fragmented supplier networks. These institutional asymmetries are consistent with broader evidence on circular transitions in developing countries. [43] noted that fragmented governance and uneven power relations constrain the diffusion of sustainability practices, while [44] found that weak financial and infrastructural support traps manufacturers in low value recycling loops. Taken together, these findings indicate that Indonesia's apparel industry faces intertwined structural and institutional barriers that limit its progression beyond compliance driven circular initiatives.

In our case, many SMEs and recyclers lacked the capacity to meet these standards and remained confined to downcycling rather than achieving full textile reuse. From a Sustainable Development Goals perspective, these results directly relate to SDGs 9 (Industry, Innovation, and Infrastructure), as the lack of recycling infrastructure, limited technological capability, and weak innovation support systems constrain the development of resilient and sustainable industrial processes within the apparel sector. At the same time, the findings align with SDGs 12 (Responsible Consumption and Production), as low consumer awareness, negative quality perceptions of recycled apparel, and fragmented reverse logistics systems hinder the transition toward responsible production and consumption patterns. Furthermore, these constraints also have implications for SDGs 13 (Climate Action), as the persistence of linear production models and low-value downcycling reduces the potential for emission reduction, energy efficiency, and climate mitigation benefits that could be achieved through high-value circular practices in the apparel industry. By highlighting these linkages, the study demonstrates how systemic governance gaps and market dynamics in emerging economies affect progress toward both sustainable industrial innovation and circular consumption practices.

On the demand side, this study highlighted the role of perceived value in influencing consumer adoption of circular apparel. Consistent with the findings [45], functional value that was reflected in product quality, durability, and usability was identified as the strongest predictor of Gen Z's intention to purchase green products, while green value acted as a moderating factor that strengthened this relationship. However, as reported [46, 47], price sensitivity and perceived utility remained dominant considerations because higher costs or uncertain product performance tended to reduce consumers' willingness to buy. These patterns were also observed in this study, where Indonesian consumers often hesitated to purchase recycled garments unless they provided comparable quality and comfort to new fabrics. Therefore, circular fashion products needed to combine functional reliability with credible environmental value to build consumer trust and effectively encourage Gen Z purchasing behaviour in emerging markets such as Indonesia.

Institutional fragmentation and regulatory voids emerged as systemic barriers to circular economy adoption in Indonesia's apparel industry. The findings showed persistent adoption in Indonesia's apparel industry. The findings showed persistent confusion over business classification where recyclers were treated as trader along with the absence of Extended Producer Responsibility (EPR) frameworks and limited enforcement capacity. In Indonesian context, the lack of coordinating body or clear regulatory mandates often left circular pilots isolated, preventing integration into national industry systems. These results were consistent with [48], who found that inadequate policy guidance, low government awareness, and poor coordination hindered circular transition in textile supply chains. [49] also noted that industrial policies still favoured linear models, lacking regulatory incentives and sectoral standards for textile recycling. Likewise, [50] reported that weak national and organizational policies represented about 17 percent of total barriers due to policymakers' limited understanding of circular principles. Overall, institutional fragmentation in Indonesia constrained collaboration and slowed the expansion of circular initiatives beyond pilot scales.

These research contributes in three main ways. First, it combines social, political, and technical dimensions via Rich Picture diagnostics, thereby exposing how power, norms, and decision boundaries shape system flows. Second, it uncovers an exclusion dynamic whereby only better-resourced or export-oriented firms could comply with circular specifications, sidelining smaller actors. Third, by explicitly linking supply constraints with consumer behaviour, it clarifies that demand pull must be credentialed by credible product performance in addition to green signalling.

Policymakers should prioritize investment in regional sorting and preprocessing hubs with quality standards. Embedding recycled content mandates or requiring take-back schemes within governmental procurement could generate guaranteed demand. Shared certification platforms or pooled compliance services

for SMEs might reduce entry friction. Industry consortia might replicate global circular partnerships adapted to Indonesia's institutional context. For brands, communicating performance equivalence and environmental narratives in tandem is essential to reduce consumer hesitation. This study focused on a single national system and a selected set of stakeholders. Future research might adopt a longitudinal or comparative design to evaluate whether infrastructure or regulatory interventions measurably improve high value recycling. Experimental pilot projects paired with impact measurement such as cost reduction and recycling rates would help validate causal pathways. Comparative studies across regions such as Southeast Asia could also test generalizability.

5. MANAGERIAL IMPLICATIONS

The findings of this study suggest that managers and policymakers in the apparel industry must adopt a systemic and collaborative approach to accelerate the implementation of circular economy practices. For policymakers, it is essential to establish clear governance structures that promote inter-ministerial coordination and include Extended Producer Responsibility (EPR) mechanisms to reduce institutional fragmentation and provide regulatory certainty. This would encourage alignment across sectors and streamline the adoption process. Apparel brands and manufacturers should integrate circular requirements into supplier engagement strategies, creating long-term partnerships with recyclers and waste management entities to ensure sustainable material sourcing. Supporting shared sorting and preprocessing infrastructure will improve the quality of recycled materials and stabilize supply chains. For small and medium-sized enterprises (SMEs), collaboration through industry associations and public-private partnerships is crucial to overcoming financial barriers, gaining access to technical expertise, and securing certification for sustainable practices. Additionally, SMEs should be supported in adopting innovative business models that facilitate the scaling of circular practices and provide access to broader markets. Lastly, managers must prioritize consumer education to overcome market scepticism surrounding circular apparel. Transparent communication about the performance, durability, and environmental benefits of circular products will help shift consumer perceptions and strengthen demand for sustainable options. By implementing these strategies, managers can improve operational feasibility, foster collaboration across stakeholders, and accelerate the transition towards a more inclusive and resilient circular apparel ecosystem, particularly in emerging economies where resources and infrastructures are often limited.

6. CONCLUSION

This study employed SSM and Rich Picture analysis to visualize and clarify the systemic challenges associated with adopting circular economy practices within Indonesia's apparel industry. The findings revealed that the circular transition remained fragmented and predominantly compliance driven, rather than transformation oriented. Structural weaknesses such as limited recycling infrastructure, unorganized textile waste collection systems, and technological constraints continued to restrict the industry's ability to move beyond low value downcycling. These technical limitations were further reinforced by weak institutional coordination and the absence of a coherent governance framework capable of aligning industrial, environmental, and market objectives.

Beyond technical barriers, the study demonstrated that social and political dynamics played a decisive role in shaping circular adoption. Power asymmetries between large brands, policymakers, and smaller actors such as SMEs, recyclers, and community innovators constrained collaborative action and limited inclusive participation. While formal authority resided within government institutions and economic power was concentrated among major manufacturers, moral and symbolic influence emerged primarily from peripheral actors without sufficient access to decision making processes. In parallel, low consumer awareness and scepticism toward recycled apparel weakened market demand, reinforcing cost pressures and discouraging broader investment in circular production models.

By integrating social, political, and technical perspectives through a systemic lens, this research contributes to a deeper understanding of how multi actor interactions shape circular economy transitions in emerging economies. The application of SSM and Rich Picture analysis extends existing circular economy literature by capturing informal relationships, governance gaps, and power relations that are often overlooked by conventional analytical approaches. The findings provide a foundation for designing more inclusive and coordinated circular strategies, emphasizing the need for collaborative governance, strengthened institutional alignment, and demand side interventions to support a more resilient and sustainable apparel ecosystem in Indonesia and similar emerging market contexts.

7. DECLARATIONS

7.1. About Authors

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7.2. Author Contributions

Conceptualization: SJ; Methodology: RP; Software: SS and HH; Validation: RP; Formal Analysis: SJ and SS; Investigation: HH; Resources: SJ; Data Curation: RP and SS; Writing Original Draft Preparation: RP; Writing Review and Editing: SJ; Visualization: HH; All authors, RP, SJ, HH, and SS, have read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7.4. Funding

This research was funded by the Indonesian Education Scholarship (BPI), administered by the Center for Higher Education Funding and Assessment, Ministry of Higher Education, Science, and Technology of the Republic of Indonesia, and the Endowment Fund for Education Agency (LPDP), Ministry of Finance of the Republic of Indonesia. The publication (article processing) charges were funded by PPM School of Management.

7.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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