

Linking Circular Economy Practices to Sustainability Performance: The Roles of Extended Producer Responsibility and Institutional Support in Ethiopian Manufacturing

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Linking Circular Economy Practices to Sustainability Performance: The Roles of Extended Producer Responsibility and Institutional Support in Ethiopian Manufacturing

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Abstract

Translating circular economy practices (CEP) into sustainability performance requires understanding the organizational mechanisms and institutional conditions through which circularity is implemented. This study examines Extended Producer Responsibility (EPR) as an intervening product-stewardship mechanism linking CEP with sustainability performance (SP) and Institutional Support (IS) as a boundary condition of the CEP–EPR and CEP–SP relationships in Ethiopian manufacturing. Data from 98 professionals with relevant manufacturing and sustainability-related experience were analyzed using partial least squares structural equation modeling (PLS-SEM). CEP was positively associated with EPR ($\beta = 0.558$, $p < 0.001$) and SP ($\beta = 0.289$, $p = 0.022$), while EPR was positively associated with SP ($\beta = 0.358$, $p = 0.004$). EPR partially mediated the CEP–SP relationship ($\beta = 0.200$, $p = 0.017$). IS significantly strengthened the CEP–EPR relationship ($\beta = 0.196$, $p = 0.010$), whereas its moderation of the direct CEP–SP relationship was not statistically significant. The findings position EPR as an intervening product-stewardship mechanism through which broader circular practices are associated with sustainability performance and show that institutional support is particularly relevant to translating circular practices into EPR implementation. By integrating the Natural Resource-Based View and Institutional Theory, the study clarifies how organizational circular practices, product stewardship, and institutional conditions interact within an emerging circular-economy context.

Keywords: Circular Economy; Extended Producer Responsibility; Product Stewardship; Sustainable Manufacturing; Resource Efficiency; Emerging Economies.

1. Introduction

Manufacturing has traditionally operated through a linear “take-make-dispose” model that places increasing pressure on natural resources and contributes to waste generation, environmental degradation, and greenhouse gas emissions [1, 2]. These concerns have increased interest in production systems that reduce resource consumption and environmental impacts while supporting industrial development. The Circular Economy (CE) offers an alternative approach aimed at retaining the value of products, materials, and resources for as long as possible. At the firm level, Circular Economy Practices (CEP), including eco-design, resource efficiency, waste minimization, and industrial collaboration, provide opportunities to reduce material losses and environmental impacts while improving resource-use efficiency [3, 4].

However, circular manufacturing extends beyond improving resource efficiency within production to managing products and materials after the point of sale. Extended Producer Responsibility (EPR) addresses this dimension by extending producers’ responsibility to post-consumer and end-of-life stages. Practices such as take-back and collection, support for recovery and recycling, collaboration with recyclers and waste-management partners, and design for end-of-life management connect circular practices with broader product-stewardship responsibilities [5, 6]. CEP and EPR are therefore related but conceptually distinct: CEP represent broader organizational circular practices, whereas EPR extends responsibility across the product lifecycle. This distinction raises an important question about whether EPR provides an organizational product-stewardship pathway through which broader

circular practices are associated with sustainability outcomes rather than functioning only as an external regulatory obligation.

This question is particularly relevant in developing economies, where circular implementation may be constrained by regulatory capacity, technical capabilities, waste-management infrastructure, incentives, and institutional coordination [7, 8]. Such constraints are especially relevant in Sub-Saharan Africa, where industrial development coincides with increasing pressures on resources and waste-management systems [9, 10]. Consequently, the relationship between firms' circular practices and sustainability outcomes may depend not only on their internal implementation of circularity but also on their ability to extend those practices into product-stewardship activities under the prevailing institutional conditions.

Ethiopia provides a relevant setting for examining these relationships. Manufacturing-led industrialization has expanded through industrial parks, export-oriented production, and broader industrial-development initiatives, alongside concerns over resource consumption, waste generation, and environmental impacts [11, 12]. More recently, the National Circular Economy Roadmap of Ethiopia identified manufacturing and industrial parks among its priority areas and emphasized resource efficiency, sustainable production, lifecycle responsibility, and an enabling environment for implementation [13]. The National Plastic Waste Management Strategy and Roadmap (2024–2034) further reflects an emerging policy direction toward EPR, resource efficiency, recycling, and stakeholder coordination [14]. Thus, the Ethiopian context brings together an emerging circular-economy policy agenda, increasing attention to producer responsibility, and institutional conditions that may influence implementation.

Despite this policy momentum, important gaps remain in understanding how these elements operate together. Research on Ethiopian manufacturing has focused mainly on cleaner production, environmental management, waste management, and sustainable production or supply-chain practices [15, 16]. More broadly, research has established relationships between circular practices and sustainability outcomes, including the role of intermediate organizational mechanisms. However, EPR research in developing economies has largely concentrated on implementation conditions, drivers, barriers, and feasibility [17, 18]. Consequently, considerably less is known about EPR as an organizational product-stewardship mechanism connecting broader CEP with environmental, economic, and social Sustainability Performance (SP).

Existing evidence reinforces the importance of distinguishing this specific mechanism. Lu and Xu [19] found relationships between EPR practices and environmental and market performance, while Chaudhary and Jain [20] reported a positive relationship between EPR implementation and organizational performance. More recently, Zhang et al. [21], using data from Chinese manufacturers, found that Individual Producer Responsibility (IPR)-based product take-back influenced environmental and financial performance indirectly through Circular Product Design (CPD). This demonstrates that producer-responsibility practices can operate through an intermediate organizational mechanism rather than having uniform direct performance effects. However, this model does not examine the relationship considered in the present study: whether EPR itself provides

the intervening product-stewardship pathway through which broader CEP are associated with multidimensional SP. Evidence on the integrated CEP–EPR–SP pathway therefore remains limited, particularly in developing-country manufacturing contexts.

A second gap concerns the role of Institutional Support (IS). Existing research shows that governmental and institutional conditions are important to CE implementation. Institutional support can provide regulatory direction, enforcement, incentives, technical assistance, and other forms of support that help firms overcome implementation barriers [22, 23]. Evidence also indicates that governmental support can promote CE implementation and that supportive institutional interventions can strengthen particular circular-economy relationships [22, 24]. This issue is particularly relevant in Ethiopia, where the national CE policy direction combines lifecycle responsibility with regulatory, technical, institutional, and financial support for implementation [13]. Yet this leaves a more specific question unresolved: whether institutional support changes the strength of relationships within the CEP–EPR–SP process. In particular, limited evidence establishes whether IS strengthens firms' extension of broader CEP into EPR implementation and whether it similarly strengthens the direct relationship between CEP and SP. Examining these relationships separately is important because institutional support may not operate uniformly across different stages of circular implementation.

Addressing these gaps requires consideration of both organizational environmental capabilities and the institutional conditions surrounding their implementation. This study therefore integrates the Natural Resource-Based View (NRBV) and Institutional Theory. The NRBV provides the organizational perspective for explaining how CEP can develop into product-stewardship activities and relate to sustainability outcomes [25], while Institutional Theory explains how external institutional conditions can support or constrain organizational responses [26, 27]. Rather than treating the two perspectives as competing explanations, the study uses them to explain different but connected components of the same circular implementation process.

Accordingly, this study examines the relationships among CEP, EPR, IS, and SP in Ethiopian manufacturing. Specifically, it investigates whether EPR mediates the relationship between CEP and SP and whether IS moderates the CEP–EPR and CEP–SP relationships. The study makes three related contributions. First, it distinguishes broader CEP from EPR and examines EPR as an intervening product-stewardship mechanism linking circular practices with sustainability performance. Second, it examines institutional support as a boundary condition of specific relationships within this process rather than treating institutional conditions only as general antecedents of CE adoption. Third, by integrating the NRBV and Institutional Theory, it provides a framework for explaining how organizational circular practices and external institutional conditions operate together in a developing-country manufacturing context. Empirically, the study extends evidence on these relationships to Ethiopia, where circular-economy and EPR policy directions are emerging but firm-level implementation remains underexamined.

2. Theoretical Foundation and Hypothesis Development

2.1.Theoretical Framework

The Natural Resource-Based View (NRBV) explains how firms can create value through environmental capabilities associated with resource efficiency, product stewardship, and sustainable development [25]. From this perspective, CEP represent organizational practices through which firms improve resource use, reduce waste, and integrate circularity into production, while EPR extends these efforts toward product stewardship and end-of-life management [28, 6]. NRBV therefore provides the capability-based explanation for the CEP–EPR–SP pathway, including the role of EPR as an intervening product-stewardship mechanism through which broader circular practices may be associated with sustainability outcomes.

Institutional Theory complements this perspective by explaining how the broader institutional environment shapes organizational responses to environmental requirements and sustainability initiatives [26, 27]. Regulation and related institutional influences can shape firms' adoption and implementation of circular practices [29, 30]. Within this broader perspective, the study focuses on institutional support (IS), reflected in regulatory clarity and enforcement, policy or financial incentives, and active government or institutional support for CE implementation. Institutional Theory therefore provides the basis for examining whether IS strengthens the CEP–EPR and CEP–SP relationships.

Together, the two perspectives provide complementary explanations: NRBV addresses the organizational pathway through which circular practices extend into product stewardship and sustainability performance, while Institutional Theory explains how supportive external conditions may strengthen firms' ability to translate circular practices into EPR implementation and sustainability outcomes.

2.2.Circular Economy Practices and Sustainability Performance

CEP translate circular economy principles into organizational practices encompassing eco-design, resource efficiency, waste minimization, and industrial collaboration. Empirical research associates these practices with reduced material and energy consumption, waste, and emissions, as well as improved cost efficiency and environmental, economic, and social performance [4, 31]. From the NRBV perspective, CEP represent environmental capabilities through which firms use resources more efficiently and address environmental constraints while creating organizational value [25]. CEP are therefore expected to contribute positively to SP.

H₁. Circular Economy Practices positively influence Sustainability Performance.

2.3.Extended Producer Responsibility as a Product-Stewardship Mechanism

EPR extends producers' responsibility to the post-consumer and end-of-life stages of products [5, 6]. Although CEP and EPR are closely related, they represent distinct aspects of circular implementation: CEP captures broader organizational circular practices, whereas EPR extends responsibility across the product lifecycle through take-back, recovery, downstream collaboration, and end-of-life management. From an NRBV perspective, this extension is consistent with product stewardship,

whereby environmental capabilities extend across the product lifecycle and relationships with downstream actors [25].

2.3.1. Circular Economy Practices and Extended Producer Responsibility

From the NRBV perspective, firms that implement broader circular practices should be positioned to extend resource efficiency and waste minimization across the product lifecycle [25]. Eco-design and industrial collaboration can support product recovery, recycling partnerships, and end-of-life management, while existing research connects circular economy implementation with lifecycle management and EPR-based take-back systems [6, 21]. Firms with stronger CEP are therefore expected to demonstrate stronger EPR implementation.

H₂. Circular Economy Practices positively influence Extended Producer Responsibility.

2.3.2. Extended Producer Responsibility and Sustainability Performance

EPR may contribute to SP by reducing waste, retaining material value, and improving resource use through take-back, recovery, recycling, and end-of-life management [5, 6]. Empirically, Lu and Xu [19] found positive relationships between EPR practices and environmental and market performance, although the financial-performance relationship was not significant, while Chaudhary and Jain [20] reported a positive relationship between EPR implementation and organizational performance. Zhang et al. [21], however, found that IPR-based product take-back influenced environmental and financial performance indirectly through circular product design. These findings indicate that the performance implications of producer responsibility may vary across performance dimensions and implementation mechanisms. Consistent with the product-stewardship perspective, EPR is therefore expected to contribute positively to SP.

H₃. Extended Producer Responsibility positively influences Sustainability Performance.

2.3.3. Mediating Role of Extended Producer Responsibility

The preceding arguments suggest that CEP can support EPR implementation and that EPR can contribute to SP. EPR may therefore transmit part of the relationship between CEP and SP. Related evidence supports the relevance of intermediate mechanisms: Zhang et al. [21] found that IPR-based product take-back influenced environmental and financial performance indirectly through circular product design. However, their model does not examine EPR as a mediator between broader CEP and SP. Evidence on the CEP–EPR–SP pathway consequently remains limited, particularly in developing-country manufacturing contexts.

H₄. Extended Producer Responsibility mediates the relationship between Circular Economy Practices and Sustainability Performance.

2.4. Institutional Support as a Moderator

Institutional Support (IS) can facilitate circular implementation by providing regulatory direction, enforcement, incentives, and other forms of support that help firms overcome implementation barriers. Such support is particularly relevant where firms face financial, technological, and infrastructure constraints [22, 23]. Research further indicates that circular implementation is shaped by institutional and economic contexts and requires supportive policy arrangements [32]. Institutional Theory therefore suggests that IS may not only encourage circular implementation generally but also influence the strength of particular relationships through which firms implement circular practices.

2.4.1. Moderating Role of Institutional Support in the CEP–EPR Relationship

Extending CEP into EPR requires firms to move beyond internal circular practices toward product take-back, recovery, recycling, downstream collaboration, and end-of-life management. Stronger IS may facilitate this transition by reducing implementation barriers and supporting firms in extending circular practices across the product lifecycle. Related empirical evidence shows that government support can promote CE implementation [22], while green government subsidies have been found to strengthen the translation of circular initiatives into cleaner production [24]. Accordingly, IS is expected to strengthen the positive relationship between CEP and EPR.

H₅. Institutional Support positively moderates the relationship between Circular Economy Practices and Extended Producer Responsibility.

2.4.2. Moderating Role of Institutional Support in the CEP–SP Relationship

IS may also shape how effectively CEP translate into SP. Stronger institutional conditions may support firms in translating circular practices into environmental, economic, and social outcomes. Existing research supports the importance of institutional conditions for circular implementation and its relationship with sustainability performance [22, 32], while Mamash et al. [24] found that green government subsidies strengthened the relationship between circular economy entrepreneurship and sustainability-oriented business performance. Accordingly, IS is expected to strengthen the CEP–SP relationship.

H₆. Institutional Support positively moderates the relationship between Circular Economy Practices and Sustainability Performance.

2.5. Conceptual Framework

The preceding arguments integrate the organizational and institutional dimensions of circular implementation within a single framework. CEP are expected to relate directly to SP and indirectly through EPR as a product-stewardship mechanism, while IS is expected to condition the CEP–EPR and CEP–SP relationships. Figure 2.1 presents the conceptual framework and the six hypothesized relationships.

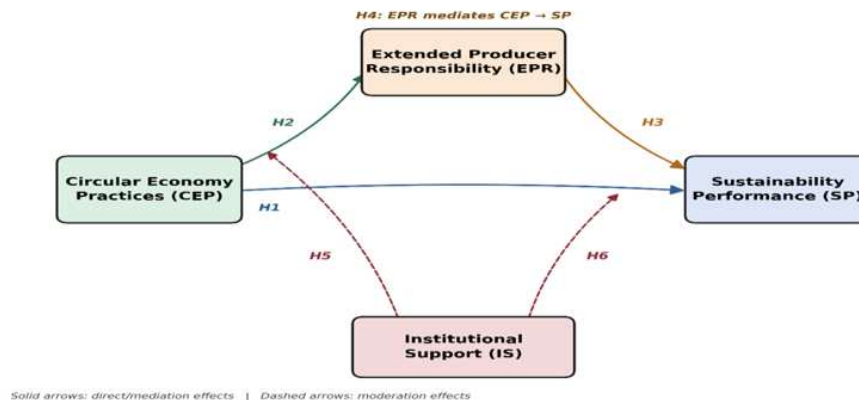


Figure 2.1. Conceptual Framework

3. Methodology

This study employed a quantitative, cross-sectional survey design to examine the relationships among Circular Economy Practices (CEP), Extended Producer Responsibility (EPR), Institutional Support (IS), and Sustainability Performance (SP) in Ethiopian manufacturing. A professional-informant approach was adopted to obtain assessments from individuals with relevant knowledge and experience of manufacturing sustainability and circular-economy issues. Respondents were drawn from manufacturing industries, government institutions, universities and research organizations, NGOs, consulting organizations, development partners, industrial parks, and industry associations. Accordingly, the responses represent professional assessments of the study constructs in the Ethiopian manufacturing context rather than observations from 98 separate manufacturing firms.

Given the absence of a comprehensive sampling frame for professionals with the required expertise, purposive sampling complemented by snowball sampling was used. Eligible participants had relevant involvement or experience in industrial sustainability, circular economy, environmental management, resource efficiency, EPR, or related manufacturing sustainability activities. The questionnaire was distributed electronically through professional networks and referrals, and participants were asked to respond based on their professional knowledge and experience.

A total of 127 questionnaires were distributed, of which 110 were returned, corresponding to a response rate of 86.6%. Following screening for completeness, relevant experience, and professional background, 98 usable responses were retained for analysis. During data cleaning, specific sector descriptions provided by respondents, including entries under the open “Other” category, were harmonized into broader sector categories to support consistent reporting of the respondent profile. Figure 3.1 summarizes the research process.

Sample-size adequacy for PLS-SEM was assessed using the inverse square root method of Kock and Hadaya [33]. At a 5% significance level and 80% statistical power, a sample of 98 corresponds to a minimum detectable standardized path coefficient of approximately 0.25. The sample was therefore adequate for detecting effects of this magnitude or larger. However, statistical sensitivity to smaller effects, particularly interaction effects, may be limited.

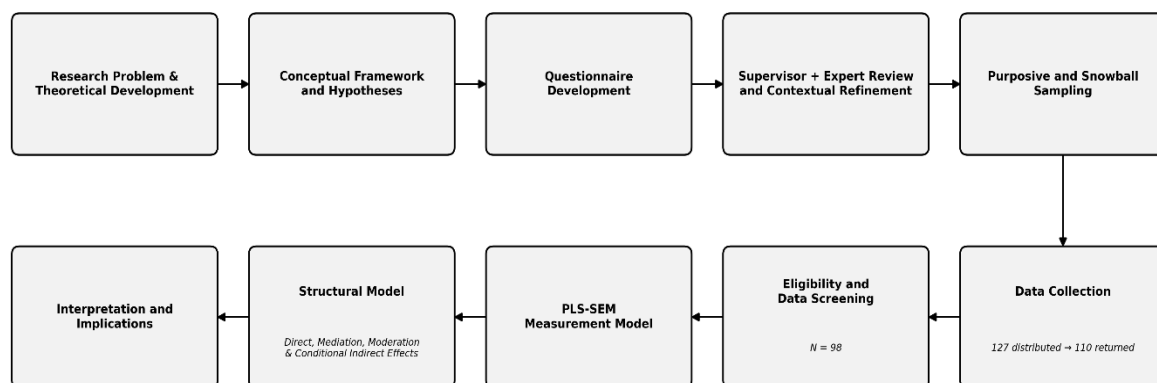


Figure 3.1. Research process of the study

The structured questionnaire was developed from established literature and adapted to the Ethiopian manufacturing context. Following supervisor review, it was pre-tested with individuals familiar with the study context from relevant government and industrial institutions. Feedback on item clarity, relevance, and contextual applicability was used to refine the instrument while preserving construct meaning. Pre-test responses were excluded from the final dataset; where participants subsequently completed the revised questionnaire, only their final responses were retained. The final instrument contained 15 items across four constructs, as summarized in Table 3.1. All items were measured using a five-point Likert scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”).

The data were analyzed using partial least squares structural equation modelling (PLS-SEM) in SmartPLS 4.1.1.8, following the two-stage assessment of the measurement and structural models recommended by Hair et al. [34]. Measurement reliability and validity were assessed before testing the direct, mediating, and moderating relationships. Statistical significance was evaluated using 5,000 bootstrap resamples, while explanatory and predictive performance was assessed using R^2 , f^2 , and PLSpredict. This analytical procedure enabled the six hypothesized relationships to be examined while distinguishing the direct CEP–SP relationship, the indirect pathway through EPR, and the conditional effects associated with IS.

Ethics approval and consent to participate

The study received ethical clearance from the Office of the Vice Executive Dean for Research and Engagement, College of Technology and Built Environment, Addis Ababa University (Ref. VEDRE/117/18/26). The study was conducted in accordance with the ethical clearance requirements and research integrity standards of Addis Ababa University. Prospective participants were informed about the academic purpose of the study, the nature of the survey, confidentiality of their responses, and the intended academic use of the information collected. Participation was voluntary, and participants who agreed to participate proceeded to complete and submit the questionnaire. No personally identifiable information was collected.

Table 3.1. Summary of Measurement Constructs

Construct	Operational Definition	No. of Items	Measurement Dimensions	Key References
CEP	Organizational practices that promote resource circularity through eco-design, resource efficiency, waste minimization, and collaboration across the manufacturing value chain.	4	Eco-design; Resource efficiency; Waste minimization; Industrial collaboration	[1, 35, 4, 31]
EPR	Organizational practices through which producers assume responsibility for product take-back, recycling, recovery, and end-of-life management across the product lifecycle.	4	Product take-back systems; Recycling support; Collaboration with recycling partners; Eco-design and end-of-life management	[36, 5, 6, 21]
IS	The extent to which the institutional environment provides regulatory, policy, financial, and implementation support for circular economy and Extended Producer Responsibility practices.	4	Environmental regulations; Regulatory enforcement; Policy and financial incentives; Government support	[22, 37, 24, 30]

SP	Organizational performance reflecting environmental, economic, and social sustainability outcomes.	3	Environmental performance; Economic performance; Social performance	[38, 25, 4, 31]
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4. Results

4.1. Respondent Profile and Preliminary Assessment

The final sample comprised 98 professionals from manufacturing and sustainability-related institutional settings. Half had more than 15 years of professional experience, while 73.5% reported 2–10 years of direct sustainability-related experience. Senior management represented 51.0% of the sample, followed by technical experts (20.4%), academic researchers (16.3%), and policy advisors or consultants (12.2%). Respondents represented manufacturing industries as well as government, academic and research institutions, NGOs, consulting organizations, development partners, industrial parks, and industry associations. Table 4.1 presents the complete respondent profile.

Table 4.1. Demographic Profile of Respondents (N = 98)

Variable	Category	Frequency	Percent (%)
Specific Industry/Sector	Textile & Apparel Manufacturing	27	27.6
	Food, Beverage & Agro-Processing	14	14.3
	Chemical & Materials Manufacturing	14	14.3
	Leather & Consumer Goods Manufacturing	11	11.2
	Circular Economy & Resource Recovery	11	11.2
	Metal & Engineering Manufacturing	8	8.2
	Multi-sector/General Industry Experts	13	13.3
	Total	98	100.0
Professional Experience	Above 15 Years	49	50.0
	11–15 Years	22	22.4
	5–10 Years	24	24.5
	Less than 5 Years	3	3.1
	Total	98	100.0
Direct CE/ Sustainability/ Manufacturing/ Policy Experience	Above 15 Years	7	7.1
	11–15 Years	18	18.4
	5–10 Years	38	38.8
	2–5 Years	34	34.7
	Less than 2 Years	1	1.0
	Total	98	100.0
Job Level	Senior Management	50	51.0
	Technical Expert	20	20.4
	Academic Researcher	16	16.3
	Policy Advisor/Consultant	12	12.2
	Total	98	100.0
Current Organization	Private Industry	35	35.7
	NGO/non-profit	19	19.4
	Academic/Research	18	18.4
	Government/Ministry	15	15.3
	Consultant/Advisor	5	5.1
	Development Partner	3	3.1
	Industrial Park	2	2.0
	Industry Association	1	1.0
	Total	98	100.0

Inner-model collinearity was assessed using variance inflation factors (VIFs), which ranged from 1.020 to 2.022, indicating no critical collinearity among the predictor constructs.

4.2.Measurement Model

The measurement model was assessed in terms of indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. Most indicator loadings exceeded 0.70. Two indicators, IS1 (0.570) and SP3 (0.626), had lower loadings but were retained because of their conceptual relevance and because their respective constructs maintained acceptable reliability and convergent validity.

Cronbach's alpha values ranged from 0.706 to 0.827, rho_A from 0.732 to 0.847, and composite reliability (rho_C) from 0.804 to 0.885. Average Variance Extracted (AVE) values ranged from 0.509 to 0.659, supporting convergent validity. The measurement-model results are presented in Table 4.2.

Table 4.2. Construct Reliability and Validity

Construct	Indicator	Loading	α	rho_A	rho_C	AVE
CEP	CEP1	0.768	0.784	0.785	0.860	0.607
	CEP2	0.814				
	CEP3	0.778				
	CEP4	0.754				
EPR	EPR1	0.722	0.827	0.847	0.885	0.659
	EPR2	0.902				
	EPR3	0.818				
	EPR4	0.795				
IS	IS1	0.570	0.706	0.732	0.804	0.509
	IS2	0.746				
	IS3	0.717				
	IS4	0.802				
SP	SP1	0.877	0.708	0.768	0.835	0.633
	SP2	0.859				
	SP3	0.626				

Discriminant validity was assessed using the heterotrait–monotrait ratio (HTMT). Values ranged from 0.405 to 0.803, with all construct pairs below the 0.85 threshold [39], supporting discriminant validity (Table 4.3).

Table 4.3. Discriminant Validity Assessment Using the Heterotrait–Monotrait Ratio (HTMT)

	CEP	EPR	IS	SP
CEP	-			
EPR	0.794	-		
IS	0.405	0.430	-	
SP	0.791	0.803	0.514	-

4.3.Structural Model and Hypothesis Testing

The structural model explained 50.5% of the variance in EPR ($R^2 = 0.505$) and 52.0% of the variance in SP ($R^2 = 0.520$). CEP was positively associated with SP ($\beta = 0.289$, $t = 2.298$, $p = 0.022$), supporting H1, and with EPR ($\beta = 0.558$, $t = 7.555$, $p < 0.001$), supporting H2. EPR was also positively associated with SP ($\beta = 0.358$, $t = 2.919$, $p = 0.004$), supporting H3. The main effects of IS on EPR ($\beta = 0.188$, $p = 0.027$) and SP ($\beta = 0.198$, $p = 0.038$) were also significant. These relationships were included as constituent terms of the moderation models but were not specified as separate hypotheses (Table 4.4).

Table 4.4. Structural Model and Direct-Effect Results

Hypothesis	Relationship	β	t-value	p-value	Decision
H ₁	CEP → SP	0.289	2.298	0.022	Supported
H ₂	CEP → EPR	0.558	7.555	< 0.001	Supported
H ₃	EPR → SP	0.358	2.919	0.004	Supported

The corresponding effect sizes (f^2) were 0.545 for CEP→EPR, 0.097 for CEP→SP, 0.132 for EPR→SP, 0.063 for IS→EPR, 0.068 for IS→SP, 0.098 for CEP×IS→EPR, and 0.018 for CEP×IS→SP. PLSpredict produced positive Q^2 predict values for EPR (0.428), SP (0.367), and all seven endogenous indicators. The PLS-SEM RMSE values were lower than the corresponding linear-model values for all endogenous indicators, indicating predictive relevance of the model.

4.4. Mediation, Moderation and Conditional Effects

The indirect CEP→EPR→SP effect was positive and statistically significant ($\beta = 0.200$, $t = 2.385$, $p = 0.017$). Because the direct CEP→SP relationship also remained positive and significant ($\beta = 0.289$, $p = 0.022$), EPR exhibited complementary partial mediation, supporting H4. The interaction between CEP and IS had a positive and significant relationship with EPR ($\beta = 0.196$, $t = 2.593$, $p = 0.010$), supporting H5. In contrast, the CEP×IS interaction for SP was not statistically significant ($\beta = 0.086$, $t = 1.148$, $p = 0.251$); therefore, H6 was not supported (Table 4.5).

Table 4.5. Mediation and Moderation Results

Hypothesis	Relationship	β	t-value	p-value	Decision
H ₄	CEP → EPR → SP	0.200	2.385	0.017	Supported
H ₅	CEP × IS → EPR	0.196	2.593	0.010	Supported
H ₆	CEP × IS → SP	0.086	1.148	0.251	Not supported

Conditional-effect analysis further clarified the significant interaction underlying H5. The CEP→EPR relationship increased from $\beta = 0.362$ ($p = 0.001$) at low IS (−1 SD), to $\beta = 0.558$ ($p < 0.001$) at mean IS, and $\beta = 0.755$ ($p < 0.001$) at high IS (+1 SD). Thus, the positive relationship between CEP and EPR was stronger at higher levels of institutional support. Although the estimated CEP→SP relationship increased numerically from $\beta = 0.203$ at low IS to $\beta = 0.289$ at mean IS and $\beta = 0.374$ at high IS, the CEP×IS interaction was not statistically significant ($p = 0.251$). The observed differences in these conditional slopes therefore do not provide statistical support for H6.

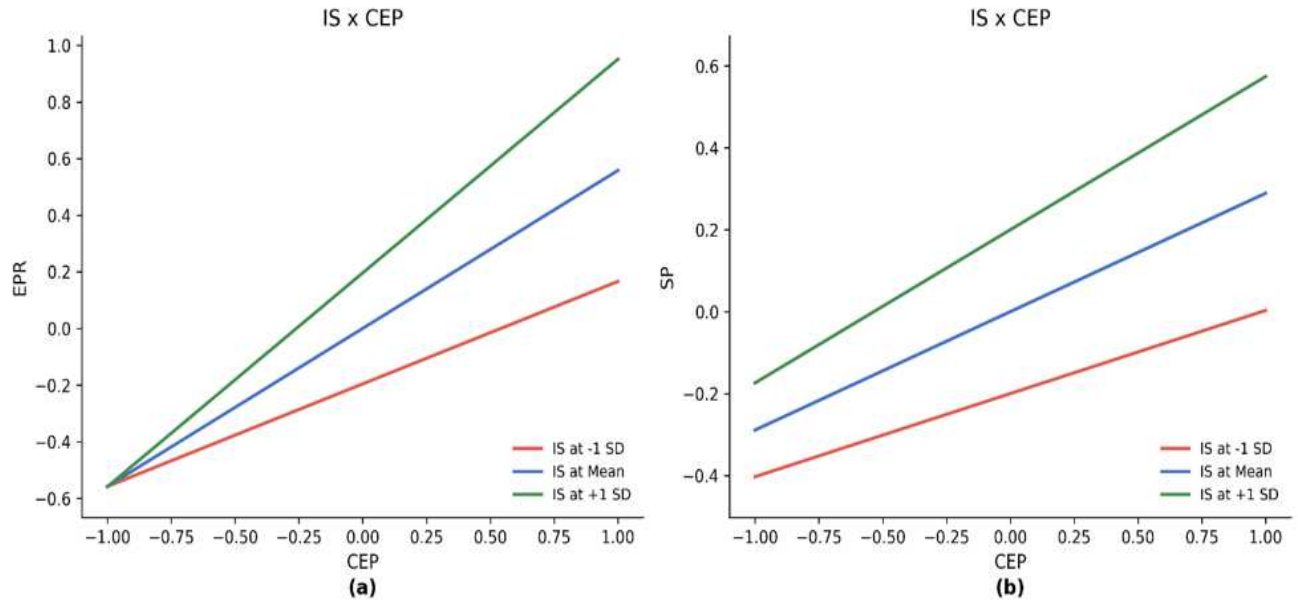


Figure 4.1. Moderating effect of institutional support.
(a) IS on the CEP–EPR relationship; (b) IS on the CEP–SP relationship.

Given the significant moderation of the CEP → EPR relationship, supplementary analysis examined the conditional indirect CEP → EPR → SP effect. The indirect effect increased from $\beta = 0.130$ ($p = 0.039$) at low IS (−1 SD) to $\beta = 0.200$ ($p = 0.017$) at mean IS and $\beta = 0.271$ ($p = 0.006$) at high IS (+1 SD). The interaction-specific indirect effect was significant ($\beta = 0.070$, $t = 2.066$, $p = 0.039$), indicating that the indirect effect through EPR strengthened at higher levels of IS.

5. Discussion and Implications

5.1. Discussion

This study examined how Circular Economy Practices (CEP) relate to Sustainability Performance (SP) in Ethiopian manufacturing by considering Extended Producer Responsibility (EPR) as an intervening product-stewardship mechanism and Institutional Support (IS) as a boundary condition. Three findings are particularly important. First, CEP were positively associated with both SP and EPR, while EPR was positively associated with SP. Second, EPR partially mediated the CEP–SP relationship, indicating that the relationship between circular practices and sustainability performance operates partly through product stewardship. Third, IS strengthened the CEP–EPR relationship but did not significantly moderate the direct CEP–SP relationship. Taken together, these findings suggest that institutional support operates selectively within the circular implementation process rather than uniformly strengthening all relationships between CEP and sustainability outcomes.

5.2. CEP, EPR, and Sustainability Performance

The positive CEP–SP relationship supports the NRBV argument that environmentally oriented organizational practices can contribute to sustainability outcomes through improved resource use and waste reduction [25]. This finding is consistent with previous research associating circular practices with environmental, economic, and social performance [4, 31]. The result therefore reinforces

existing evidence that CEP are relevant to sustainability performance rather than representing environmental practices disconnected from organizational outcomes.

The strong positive relationship between CEP and EPR adds an important lifecycle dimension to this finding. Although CEP and EPR share circular economy principles, they capture different aspects of implementation. CEP encompass broader organizational practices such as eco-design, resource efficiency, waste minimization, and industrial collaboration, whereas EPR extends responsibility toward take-back, recovery, recycling collaboration, and end-of-life management. The observed CEP–EPR relationship is therefore consistent with the NRBV product-stewardship perspective: firms exhibiting stronger circular practices are also more likely to extend responsibility beyond internal production activities toward the broader product lifecycle [25, 6].

EPR, in turn, was positively associated with SP. This is broadly consistent with Lu and Xu [19], who reported positive relationships between EPR practices and environmental and market performance, although their financial-performance relationship was not significant, and with Chaudhary and Jain [20], who reported positive organizational-performance implications of EPR implementation. The present result extends this evidence by considering SP as a multidimensional construct incorporating environmental, economic, and social outcomes.

The more important finding, however, concerns the position of EPR within the CEP–SP relationship. EPR partially mediated this relationship, indicating that broader CEP were associated with SP both directly and indirectly through organizational product stewardship. This complements Zhang et al. [21], who identified an indirect producer-responsibility pathway through circular product design, although their model configuration differs from the present study. The present study identifies a different configuration in which EPR itself occupies the intervening position between broader CEP and SP.

The partial rather than complete mediation is also meaningful. It suggests that EPR represents one pathway through which CEP are associated with SP, but not the only pathway. Circular practices such as resource efficiency, waste minimization, and eco-design may also relate to sustainability outcomes independently of producer-responsibility implementation. EPR should therefore be understood as a complementary product-stewardship mechanism rather than as a substitute for broader circular practices. Because SP was measured as an aggregated construct incorporating environmental, economic, and social dimensions, these findings concern sustainability performance as operationalized in this study. They should not be interpreted as demonstrating identical CEP or EPR relationships with each individual performance dimension.

5.3. The Moderating Role of Institutional Support

The moderation results provide a more differentiated understanding of the institutional environment. IS significantly strengthened the CEP–EPR relationship, consistent with Institutional Theory's argument that organizational responses are shaped by regulatory and institutional conditions [26, 27]. This is also consistent with evidence that government support can facilitate CE implementation [22, 23] and with Mamash et al. [24], who found that government subsidies strengthened the translation of circular initiatives into cleaner production. The conditional effects reinforce this interpretation. The CEP–EPR relationship increased from $\beta = 0.362$ under low IS to $\beta = 0.755$ under high IS. This suggests that supportive institutional conditions are particularly relevant when firms extend broader circular practices into product-stewardship activities. EPR

implementation can require coordination beyond organizational boundaries, including take-back arrangements, recycling and recovery systems, downstream partnerships, regulatory guidance, and end-of-life management. Institutional support may therefore be especially consequential at this stage of circular implementation.

In contrast, IS did not significantly moderate the direct CEP–SP relationship. This nonsignificant finding is theoretically informative because it indicates that institutional support should not be assumed to strengthen every relationship between circular practices and sustainability outcomes. Although the conditional CEP–SP slopes increased numerically as IS increased, the interaction itself was not statistically significant. The evidence therefore supports a path-specific institutional effect: IS strengthens the translation of CEP into EPR but does not significantly alter the direct CEP–SP relationship.

The supplementary conditional indirect analysis provides further support for this interpretation. The indirect CEP→EPR→SP relationship increased from $\beta = 0.130$ under low IS to $\beta = 0.271$ under high IS, and the interaction-specific indirect effect was statistically significant. Because this analysis was supplementary rather than a separately hypothesized relationship, it should be interpreted as additional evidence clarifying the significant CEP×IS→EPR interaction rather than as an independently hypothesized moderated-mediation result. Taken together, the results indicate that institutional support is particularly relevant to the product-stewardship pathway through which CEP are associated with SP.

This distinction is especially relevant in the Ethiopian context. Emerging CE and EPR policy directions can establish an enabling environment, but the findings suggest that the contribution of institutional support may depend on where it enters the implementation process. Support directed toward regulatory clarity, incentives, implementation assistance, and coordination may be particularly valuable for helping organizations extend existing circular practices toward producer-responsibility activities rather than being expected to generate sustainability performance independently of organizational practices.

5.4.Theoretical Implications

This study contributes theoretically by clarifying both the mechanism and the boundary condition linking circular practices with sustainability performance. First, it extends the NRBV perspective by distinguishing broader CEP from EPR and showing that EPR partially mediates the CEP–SP relationship. This positions EPR not merely as a regulatory requirement or standalone circular practice, but as an intervening product-stewardship mechanism through which broader circular practices are associated with sustainability performance. Second, the study refines the institutional explanation of circular implementation. IS strengthened the CEP–EPR relationship but did not significantly moderate the direct CEP–SP relationship, indicating that institutional support does not operate uniformly across the circularity–performance process. Rather, its role appears path-specific, particularly in supporting the translation of broader circular practices into product-stewardship implementation. Together, these findings provide a complementary integration of NRBV and Institutional Theory: NRBV explains the organizational CEP–EPR–SP pathway, while Institutional Theory explains an important boundary condition of that pathway. The contribution therefore lies not

simply in combining the two theories, but in showing how organizational circular practices and institutional conditions perform distinct but connected roles in the relationship between circularity and sustainability performance.

5.5. Practical and Policy Implications

For manufacturing practice, the findings suggest that circular initiatives should not stop at internal improvements in resource efficiency and waste minimization. Firms pursuing CEP can strengthen their sustainability efforts by extending circular practices toward product stewardship through take-back arrangements, recovery and recycling activities, collaboration with recycling and waste-management partners, and greater attention to end-of-life responsibility. Because EPR only partially mediated the CEP–SP relationship, these activities should complement rather than replace broader circular practices.

The findings also have implications for how institutional support is targeted. The significant $\text{CEP} \times \text{IS} \rightarrow \text{EPR}$ interaction suggests that supportive institutional conditions are particularly relevant to the implementation of producer responsibility. Policymakers and supporting institutions can therefore focus on conditions that enable firms to extend circular practices across the product lifecycle, including regulatory clarity and enforcement, appropriate policy and financial incentives, implementation support, and coordination among manufacturers, recyclers, waste-management actors, and relevant public institutions.

This implication is consistent with Ethiopia's National Circular Economy Roadmap, which emphasizes lifecycle responsibility and an enabling environment for CE implementation [13], and the National Plastic Waste Management Strategy and Roadmap (2024–2034), which gives increasing attention to EPR, recycling, resource efficiency, and stakeholder coordination [14]. The findings suggest that these institutional measures may be particularly important when they help translate firms' existing circular practices into operational producer-responsibility systems.

At the same time, the nonsignificant moderation of the CEP–SP relationship cautions against assuming that stronger institutional support automatically increases the sustainability returns associated with circular practices. Within the present model, the clearer institutional role lies in strengthening the CEP–EPR implementation pathway. Policy interventions should therefore complement firms' own circular practices and implementation efforts rather than be viewed as substitutes for organizational capability.

6. Conclusion, Limitations and Future Research Directions

This study examined how Circular Economy Practices (CEP), Extended Producer Responsibility (EPR), and Institutional Support (IS) are associated with Sustainability Performance (SP) in Ethiopian manufacturing. The findings show that CEP are positively associated with SP both directly and indirectly through EPR, supporting the role of EPR as an intervening product-stewardship mechanism. Institutional support strengthened the CEP–EPR relationship but did not significantly moderate the direct CEP–SP relationship, indicating that its role is path-specific rather than uniform across the circularity–performance process. Overall, the study contributes by distinguishing broader

circular practices from producer-responsibility implementation and showing how organizational product stewardship and institutional conditions occupy different but connected roles in the CEP–SP relationship.

These findings should be interpreted within the study's limitations. First, the cross-sectional design does not establish temporal ordering or causal relationships among CEP, EPR, IS, and SP. Second, the findings are based on professional assessments collected through a single questionnaire and may therefore be subject to perceptual and common-method influences. Third, the purposive and snowball sample of 98 professionals does not constitute a probability-based sample of Ethiopian manufacturing firms, limiting statistical generalizability; the sample size may also reduce sensitivity to smaller effects, particularly interaction effects. Finally, the aggregated measurement of SP and IS does not reveal whether the relationships differ across environmental, economic, and social performance dimensions or across specific forms of institutional support. These limitations define the scope of the conclusions rather than invalidating the observed relationships.

Future research can strengthen and extend these findings through longitudinal designs that establish temporal ordering, larger and more representative samples where feasible, and firm-level studies incorporating multiple informants and objective performance indicators. Disaggregating SP into environmental, economic, and social dimensions and examining specific forms of institutional support could clarify where the observed relationships are strongest. Further testing of the CEP→EPR→SP pathway across industries and institutional contexts would also help determine the broader applicability of EPR as a product-stewardship mechanism and the conditions under which institutional support facilitates its implementation.

Statements and Declarations

Funding: No funding was received for conducting this study.

Competing interests: The authors have no relevant financial or non-financial interests to disclose.

Data availability: The data supporting the findings of this study are available from the corresponding author on reasonable request, subject to appropriate confidentiality considerations.

Ethics approval: The study received ethical clearance from the Office of the Vice Executive Dean for Research and Engagement, College of Technology and Built Environment, Addis Ababa University (Ref. VEDRE/117/18/26). The study was conducted in accordance with the ethical clearance requirements and research integrity standards of Addis Ababa University.

Consent to participate: Prospective participants were informed about the academic purpose of the study, the nature of the survey, confidentiality of their responses, and the intended academic use of the information collected. Participation was voluntary, and participants who agreed to participate proceeded to complete and submit the questionnaire.

Consent for publication: Not applicable. No personally identifiable information is reported in this article.

Author contributions: Masresha Tasew Habtamu led the study design and methodology, data collection, analysis and interpretation, preparation of figures and tables, and drafting of the manuscript. Daniel Kitaw Azene contributed to the original research concept, assisted with analysis and interpretation of the results, and critically reviewed the manuscript, providing substantive suggestions and comments. Kassu Jilcha Sileyew supervised the research and critically reviewed and revised the manuscript. Hafte Tkue Geberekidan contributed to manuscript review, assisted with analysis and interpretation of the results, and supported preparation of the manuscript for submission. Gezahegn Tesfaye Dadi co-supervised the research and contributed to critical review and revision of the manuscript.

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Appendix

Part A. Respondent Profile

1. Current Organization Type: Private Industry; Ministry/Government; Industrial Park; Academic/Research; NGO (non-profit organization); Industry association leaders; Other: _____
2. Years of Professional Experience: Less than 5 years; 5–10 years; 11–15 years; Above 15 years
3. Direct Experience with Circular Economy (CE) / Sustainability / Manufacturing / Policy: 2–5 years; 5–10 years; 11–15 years; Above 15 years; Other: _____
4. Specific Manufacturing Industry Sector: Textile & Apparel; Leather & Products; Food & Beverage; Chemicals; Metal/Machinery manufacturing; Other: _____
5. Job Level: Senior Management; Technical Expert; Policy Advisor/Consultant; Academic Researcher; Other: _____

Part B. Construct Measurement Items

Response scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree.

Construct	Code	Measurement Item
Circular Economy Practices (CEP)	CEP1	Manufacturing firms in Ethiopia design products for reuse, recyclability, and reduced environmental impact.
	CEP2	Manufacturing firms in Ethiopia implement resource efficiency measures (energy, water, and materials efficiency).
	CEP3	Manufacturing firms in Ethiopia minimize waste through recycling, reuse, and recovery practices.
	CEP4	Manufacturing firms in Ethiopia engage in collaboration or industrial symbiosis to optimize resource use (e.g., resource/material sharing among firms).
Extended Producer Responsibility (EPR)	EPR1	Manufacturing firms in Ethiopia implement product take-back and collection systems.
	EPR2	Manufacturing firms in Ethiopia finance or support recycling and recovery of their products.
	EPR3	Manufacturing firms in Ethiopia collaborate with recyclers or waste management partners.
	EPR4	Manufacturing firms in Ethiopia design products and processes to improve end-of-life management and comply with Extended Producer Responsibility (EPR) regulations.
Sustainability Performance (SP)	SP1	Manufacturing firms in Ethiopia reduce energy use, emissions, and environmental impacts through efficient resource utilization and waste minimization practices
	SP2	Manufacturing firms in Ethiopia achieve economic benefits and long-term financial sustainability from sustainable practices like resource efficiency, recycling, and waste reduction.
	SP3	Manufacturing firms in Ethiopia contribute to employee well-being, societal and local communities' development.
Institutional Support (IS)	IS1	The institutional environment in Ethiopia provides clear environmental regulations for manufacturing firms.
	IS2	Environmental laws and regulations are effectively enforced.
	IS3	There are sufficient incentives (e.g., financial or policy support) for adopting Circular Economy (CE) and Extended Producer Responsibility (EPR) practices.
	IS4	Government and institutions actively support firms in implementing Circular Economy (CE) initiatives.