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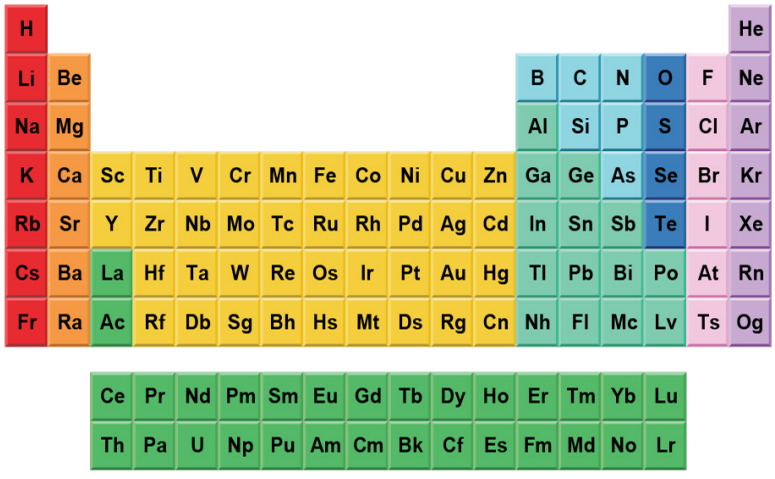
To cite this article: Chitra Almira De Oganysha *et al* 2026 *IOP Conf. Ser.: Earth Environ. Sci.* **1650** 012028

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Preliminary validation of circular economy entrepreneurship, circular economy practices, sustainable supply chain management and sustainability performance constructs among smallholder coffee farmers in West Java

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Abstract. The shift toward a circular economy requires measurement tools that work not only in industrial settings but also in smallholder agricultural systems. However, such instruments remain limited. This study provides an early validation of four key circular economy constructs—Circular Economy Entrepreneurship (CEE), Circular Economy Practices (CEP), Sustainable Supply Chain Management (SSCM), and Sustainability Performance (SP)—using a pilot survey of 30 smallholder coffee farmers in West Java, Indonesia. Adapted indicators were evaluated through reliability and item–total correlation analyses. CEE emerged as the most consistent construct, while CEP and SSCM showed moderate alignment with farmers' current practices. Several items were identified as weak, particularly those involving resource efficiency, value-added processing, and digital coordination. SP presented the lowest reliability, highlighting the need for clearer sustainability indicators in smallholder contexts. These findings offer practical insights for refining circular economy measurement tools and lay the groundwork for more robust, large-scale assessments.

1. Introduction

The accelerating depletion of natural resources and the increasing environmental pressures from production and consumption activities have raised global concern regarding the sustainability of current economic systems. The traditional linear "take–make–dispose" model has long been identified as a major driver of resource inefficiency and waste generation [1][2]. In response, the circular economy (CE) has emerged as a transformative framework that promotes resource optimization through reduction, reuse, recycling, and remanufacturing strategies [3]. This

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paradigm aims not only to minimize environmental impacts but also to stimulate innovation and sustainable economic growth [4].

Within this transition, Circular Economy Entrepreneurship (CEE) plays a strategic role in enabling business innovation rooted in circular principles. Entrepreneurs who adopt CE thinking can convert limitations and waste streams into value-added opportunities, thereby strengthening resilience and enhancing sustainability-oriented business models [5][6]. However, in lower to lower middle-income countries such as Indonesia, smallholder producers and local enterprises often face constraints including limited capital, insufficient technical knowledge, and restricted access to technology that hinder the adoption of circular practices [7]. This condition underscores the need for reliable and context-sensitive measurement tools to assess entrepreneurial readiness toward circular economy principles.

At the operational level, Circular Economy Practices (CEP) such as material recovery, waste reduction, and resource efficiency are closely connected to Sustainable Supply Chain Management (SSCM). SSCM integrates environmental, social, and economic considerations across production and distribution processes, fostering collaboration and reducing waste along supply chains [8][9][10][11]. When implemented effectively, circular practices can strengthen supply chain coordination, improve environmental performance, and generate broader sustainability benefits.

These concepts are highly relevant to Indonesia's coffee sector, where smallholder farmers dominate production. Coffee cultivation produces substantial organic residues, including pulp, husk, and spent grounds, which hold potential for composting or value-added by-products but remain underutilized in many farming communities [12]. Understanding how circular and sustainable practices can be embedded in smallholder systems therefore requires empirical instruments that accurately capture circular entrepreneurship, operational circularity, and sustainability performance.

However, existing studies on CE measurement predominantly focus on manufacturing or industrial settings [11][13]. Only a limited number have examined the validity of these constructs in agricultural or smallholder-based contexts, where socio-economic structures differ significantly from formal industrial environments. Before examining the relationships among CEE, CEP, SSCM, and sustainability outcomes, it is essential to establish whether the measurement items are reliable and appropriate for smallholder conditions.

This study aims to conduct a preliminary validation of measurement constructs for CEE, CEP, SSCM, and Sustainability Performance (SP) among smallholder coffee farmers in West Java, Indonesia. By evaluating internal consistency and item validity through a pilot survey, this research provides early methodological evidence to refine the instrument prior to large-scale application. The validated indicators are expected to strengthen CE-related assessment tools within agri-food systems in emerging economies.

2. Methodology

2.1 Research design

This study employed a quantitative descriptive approach to conduct a preliminary validation of four measurement constructs: Circular Economy Entrepreneurship (CEE), Circular Economy Practices (CEP), Sustainable Supply Chain Management (SSCM), and Sustainability Performance (SP). The aim of this initial stage was not to test causal relationships, but to assess whether the adapted items are reliable and appropriate for use in smallholder farming settings.

The questionnaire was developed by adjusting measurement items from previous circular economy and sustainability studies, and then contextualizing them for coffee smallholders. This pilot validation serves as the foundation for a larger-scale survey and subsequent structural model testing.

2.2 Population and sampling

The research was conducted among smallholder coffee farmers in Mekarwangi Village, Sindangkerta District, West Bandung, West Java. Respondents were selected using purposive sampling with two criteria:

- at least three years of coffee farming experience, and
- basic exposure to waste-related or sustainability practices.

A total of 30 farmers participated in this pilot survey. Although relatively small, this sample size aligns with recommended ranges for early reliability assessment (20-40 respondents) aimed at identifying items that may require refinement before broader application.

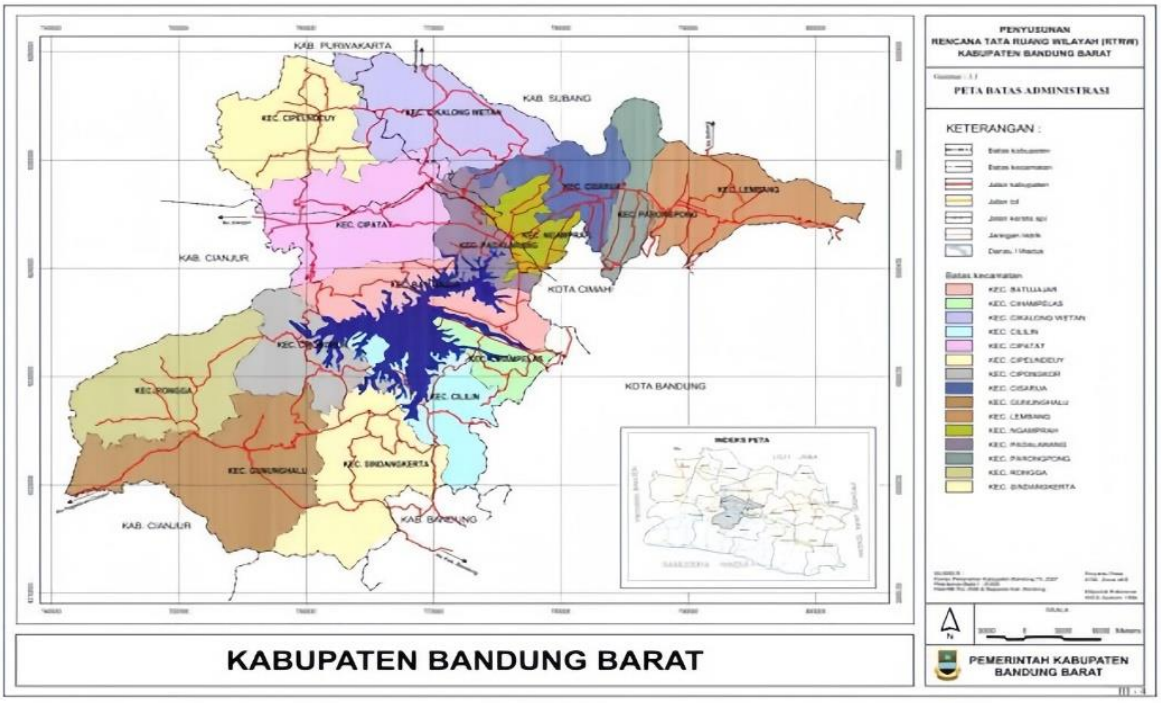


Figure 1. Map of Bandung Barat Regency

2.3 Data collection

Data were collected through a structured questionnaire distributed directly to farmers in September 2025. Prior to distribution, the questionnaire underwent expert review to ensure clarity and relevance. It was also translated into Bahasa Indonesia, and key concepts such as waste reuse, composting, and by-product utilization were briefly explained to minimize misunderstanding.

The instrument consisted of statements measured on a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree). Completed questionnaires were coded and analyzed using SPSS 25 for reliability and validity testing.

2.4 Variable and measurement

The operationalization of the four constructs is as follows:

- Circular Economy Practices (CEP): Eight items adapted from prior circular economy and supply chain studies, including indicators related to material reuse, composting, and waste reduction [9][14][15].
- Sustainable Supply Chain Management (SSCM): Eight items reflecting supplier-buyer collaboration, logistics efficiency, and alignment of sustainability objectives [8][16][17].
- Circular Economy Entrepreneurship (CEE): Five items capturing entrepreneurial initiative, opportunity recognition in waste valorization, and innovation toward circularity [5][18].
- Sustainability Performance (SP): Six items measuring economic, environmental, and social dimensions based on triple bottom line principles [19][20][21].

All variables were designed as reflective multi-item scales. Items with weak statistical performance were flagged for refinement in the next research phase.

2.5 Data analysis technique

Descriptive statistics were used to summarize respondent characteristics and overall response patterns. Reliability testing was conducted using Cronbach's alpha, with values above 0.70 considered good and values between 0.60-0.70 acceptable for exploratory research.

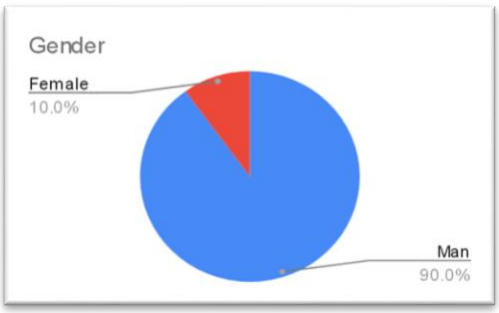
Item-total correlation analysis was then performed to evaluate construct validity. Items with low correlation values were identified as potentially unclear or conceptually inconsistent and will be revised prior to large-scale deployment.

This analytical procedure provides an initial assessment of the psychometric quality of the measurement items and informs improvements for subsequent stages of the study.

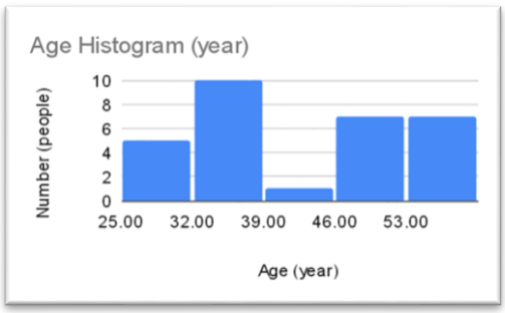
3. Result and Discussion

3.1 Descriptive analysis

The descriptive analysis provides an overview of the demographic and farming characteristics of the 30 smallholder coffee farmers who participated in the pilot survey. Most respondents were male and belonged to the productive age group of 30-45 years. The majority had completed secondary education, managed between 0.5-2 hectares of Arabica coffee, and had farming experience of around 10 years. Approximately two-thirds of respondents were members of local cooperatives, while the others farmed independently.



(a)



(b)

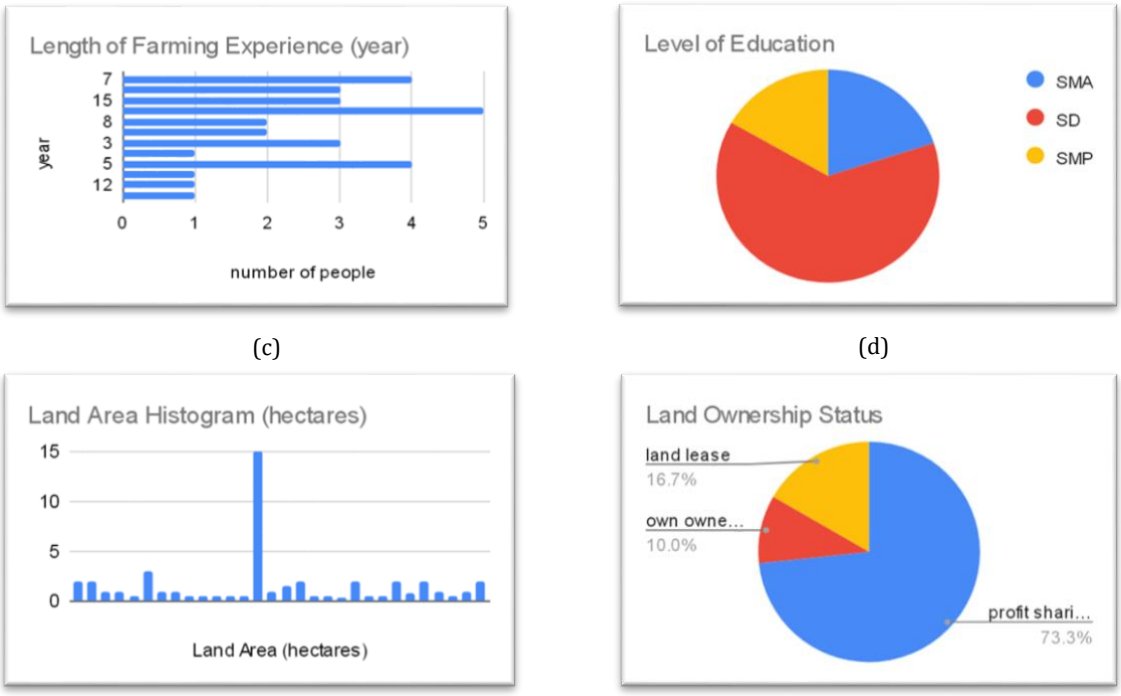


Figure 2. (a) Farmer's gender; (b) Age distribution of farmers; (c) Farmer's education level; (d) Land area; (e) Land ownership status; (f) Length of farming experience.

These characteristics suggest that while farmers have moderate farming experience, their exposure to structured circular economy or sustainability practices remains limited. This contextual understanding is important for interpreting how well the measurement items align with farmers' real-world knowledge and practices.

3.2 Reliability and validity results

Reliability and validity analysis was conducted using Cronbach's alpha and item–total correlations. The CEE construct demonstrated the highest internal consistency ($\alpha = 0.816$), indicating strong coherence among the five items. CEP ($\alpha = 0.678$) and SSCM ($\alpha = 0.637$) showed acceptable reliability for a pilot study, while SP ($\alpha = 0.512$) had the lowest coefficient, suggesting the need for refinement.

Item-total correlation analysis revealed that most indicators aligned positively with their respective construct totals. However, a few items in CEP and SP exhibited weaker correlations ($r < 0.30$), indicating that the wording may be unclear or the concepts may be interpreted differently in the smallholder context. These items will be revised in the next phase of instrument development.

Table 1. Reliability Result

Variable	Number of Items	Valid Items	Cronbach's Alpha	Interpretation
Circular Economy Entrepreneurship (CEE)	5	5	0.816	Highly reliable
Circular Economy Practices (CEP)	8	6	0.678	Moderately reliable
Sustainable Supply Chain Management (SSCM)	8	7	0.637	Moderately reliable
Sustainability Performance (SP)	6	6	0.512	Low reliability-needs revision

[a] *Source: Preliminary survey data (n = 30), SPSS 25.0*

3.3 Discussion of reliability and construct meaning

The reliability results show that CEE has the strongest internal consistency, suggesting that circular-oriented entrepreneurial behaviors are relatively clear and familiar to farmers. CEP and SSCM demonstrate moderate reliability, indicating that some operational items may not fully reflect local practices.

For the CEP construct, two items showed weak correlations. The item on resource efficiency did not perform well because most farmers have not adopted water-saving or material-efficient practices, making the statement less representative of their actual behavior. Another item related to producing value-added products (such as cascara or compost) was also weak, as farmers typically sell coffee cherries directly to collectors without engaging in processing activities. These findings indicate that CEP items involving innovation or post-harvest transformation may need to be simplified to match farmers' day-to-day activities.

In the SSCM construct, one item related to the use of digital tools such as WhatsApp groups or agricultural apps to monitor market demand was not valid. This is consistent with current practices in the area, where farmers rely on direct transactions with collectors and do not use digital platforms for market information.

The SP construct remains the least reliable, reflecting varied interpretations of sustainability. Respondents often equate "performance" primarily with economic outcomes, while environmental and social indicators feel less tangible. This explains the inconsistent responses across SP items.

Overall, the pilot results confirm that the instrument is suitable for early validation, while also highlighting specific items that require contextual refinement. Adjusting these weaker indicators will strengthen construct clarity before the instrument is applied in a larger and more diverse sample.

4. Conclusion

This study conducted a preliminary validation of measurement constructs for Circular Economy Entrepreneurship (CEE), Circular Economy Practices (CEP), Sustainable Supply Chain Management (SSCM), and Sustainability Performance (SP) among smallholder coffee farmers in West Java. The findings show that most constructs reached acceptable reliability levels for a pilot study, with CEE performing the strongest and SP requiring the most refinement. Several items in CEP and SSCM also showed low validity due to misalignment with farmers' actual practices, particularly those involving resource efficiency, value-added processing, and digital market coordination.

Overall, the results indicate that the instrument is suitable for early-stage validation and provides clear guidance for improving item clarity and contextual relevance. Refining the weaker items and expanding the sample size in future research will help strengthen the measurement model and support more robust analysis of circular economy dynamics in smallholder agricultural systems. The validated constructs are expected to contribute to better assessment tools for understanding circular adoption and sustainability performance in agri-food sectors of emerging economies.

5. Acknowledgments

The authors gratefully acknowledge the financial support provided by the Ministry of Higher Education, Science, and Technology (Kemdiktisaintek) through the BIMA Program under the Master Thesis Research Scheme (PTM) 2025. This research was funded under the Master Contract Number 093/C3/DT.05.00/PL/2025 dated May 28, 2025, and the Sub-Contract Number 1689/UN6.3.1/PT.00/2025 dated June 2, 2025. This support significantly contributed to the completion of this research.

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