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Confirmatory Factor Analysis of Circular Economy Practices (5r Framework) at Andri 99 Leather Garut

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ABSTRACT

This research aims For verify structure factor circular economy practices based on the 5R framework (reduce, reuse, recycle, recover, and redesign) in industry skin scale small Andri 99 Leather Garut. Although circular economy concept has Lots being discussed , still little empirical evidence to test relatedness fifth 5R principles in general simultaneously in context industry small companies that use production processes traditional . This research applies approach quantitative with the Confirmatory Factor Analysis (CFA) method for determine whether the implementation of 5R creates One integrated or multidimensional construct . Data obtained through survey to all over craftsmen who play a direct role in activities operational as the population involved completely . The results of the analysis show that the data is valid For processed further (KMO = 0.866; value Bartlett's Test significance = 0.000) and all 5R indicators have mark high loading factor (0.773–0.900) on one factor main with an eigenvalue of 3.633 which is capable of explained 72.65% of the total variance . This finding confirms that Circular economic practices based on 5R in leather SMEs scale small is unidimensional and integrated . This research provides contribution empirical in measuring the circular economy in the MSME sector as well as implications practical For development policies and assistance sustainability industry small based craft.

Keywords: Author circular economy; 5R framework ; confirmatory factor analysis; industry small and medium sized industries skin*.*

INTRODUCTION

Economic and environmental sustainability are increasingly pressing global issues, particularly due to production and consumption patterns still dominated by linear systems. The surge in industrial activity has led to the extraction of natural resources outpacing the ecosystem's ability to recover. UNEP data (2023) shows that approximately 90% of the majority of materials extracted from nature end up as waste without optimal recycling. This situation reinforces the urgency of transitioning to a circular economy model as a new, more adaptive economic approach to environmental challenges. The circular economy emerges as a response to the limitations of the take-make-dispose model, emphasizing the 5R principle: reducing inefficient materials (reduce), extending their useful life (reuse), reprocessing (recycle), recovering value from production waste (recovery), and designing innovations to make products more recyclable (redesign). This approach

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not only reduces the waste burden but also opens up new opportunities for production efficiency and innovation across various industrial scales.

Globally, the European Union is one of the most progressive examples of circular strategy adoption, with policies targeting carbon neutrality and a 50% reduction in production waste by 2030. Countries like the Netherlands and Japan have also demonstrated that a circular economy can be a powerful tool for strengthening small- and medium-scale manufacturing industries, particularly through production efficiency and the optimization of industrial waste materials. Indonesia has begun to follow a similar trend through its 2020–2024 National Medium-Term Development Plan (RPJMN) and Presidential Regulation No. 98 of 2021, which emphasizes the use of waste as a new production input, particularly in the Small and Medium Enterprises (SME) sector. Garut Regency in West Java is known as the largest leather industry center in Indonesia. This industry plays a significant role in the local economy, both in terms of employment and income contribution for artisans and businesses. Despite its high potential, the leather production chain still faces significant environmental challenges. The tanning stage, which relies on chemical compounds such as chromium and sulfur, produces large amounts of liquid and solid waste.

In small-scale businesses like Andri 99 Leather, the production process is still carried out manually using traditional methods, resulting in production waste in the form of leather scraps, adhesive residues, and unused chemical residues. The urgency of this research becomes clearer when compared to regional regulations, such as West Java Regional Regulation No. 32 of 2009 concerning Environmental Protection and Management, the implementation of which in the SME sector has not been optimal. The main obstacles facing small-scale artisans include limited access to environmentally friendly tools, access to financing, and minimal technical assistance. As a result, leather waste, which empirically has potential economic value, is often wasted, despite several previous studies demonstrating its potential for utilization.

Initial findings from interviews with 10 artisans indicate that the majority (approximately 70%) do not yet understand the concept of a circular economy. The other 30% have attempted to implement circular practices, but these are still limited to basic initiatives such as waste reduction, without addressing waste processing into new economic value. This indicates a gap in implementation between large producers with centralized waste management systems and small-scale artisans who still rely on linear production patterns. The concept of sustainability in economics itself emphasizes the harmonization of business growth, the welfare of industry players, and environmental responsibility, as measured through an ESG (Environmental, Social, and Governance) perspective. In the context of leather craftsmen, sustainability is no longer just about profit, but also about how production processes are run efficiently, cleaner, and still provide a fair economic impact for artisans. Although the idea of a circular economy has made significant progress and become a key strategy for promoting sustainability in the industry, empirical studies examining its application in the Small and Medium Enterprises (SME) sector still show many

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shortcomings. Previous research generally emphasizes that implementing a circular economy can have a positive impact on resource efficiency, waste reduction, and increased business sustainability (Siregar, 2022) .

However, the majority of these studies still focus on the circular economy as a partial approach, with a greater emphasis on one or two principles, such as reduce or reuse, without analyzing the interconnectedness and impact of all 5R principles within a comprehensive model. Furthermore, the focus of previous studies has been directed more towards MSMEs in general or industries already supported by waste processing technology and semi-mechanized production systems. This has resulted in limited empirical evidence reflecting the characteristics of small-scale leather SMEs, which rely on traditional production processes, have very limited access to green technology, and are not yet integrated into centralized waste management systems. Yet, the leather industry is a sector with enormous waste potential and also offers significant opportunities to implement circular economy principles based on the utilization of production waste that has economic value.

Research conducted by (Rahmawati & Nanda, 2021) shows that waste management in leather SMEs is still dominated by efforts to reduce waste without any further utilization strategies. (Putra & Wulandari, 2023) found that leather waste has the potential to become a source of energy and organic fertilizer, but has not yet linked this directly to the sustainability of artisan businesses. On the other hand, (Akbar, 2024) emphasized that access to green technology is still focused on certain types of MSMEs, while small SMEs are lagging behind in the transition to a circular economy. idea regarding the circular economy (CE) has Lots discussed in the literature academic , research that tests its implementation in the sector Small and Medium Industries (SMEs), especially in the industry skin scale small with production methods traditional , is still very little . Most of the existing research previously only see circular economy practices in a way separate with a focus on one or two 5R principles , such as reduction or use back , without study How fifth these principles function in one framework complete practice .

In addition, there are debate theoretical in literature regarding whether circular economy practices based the 5R approach should be seen as something dimensional construct many are separate or as One an integrated construct that describes practice operational circular in a way comprehensive . This limitation results in absence clarity empirical about structure Circular economy factors in the context of leather SMEs scale small ones who have limitations in technology and understanding environment . This research takes position in the discussion about whether the implementation of a circular economy follows The 5R framework (reduce, reuse, recycle, recover, and redesign) creates One integrated (unidimensional) or more constructs multidimensional in context industry skin scale small . Different from study previously targeting MSMEs in particular general or sectors with semi- mechanical production methods , this study is special research characteristics of leather SMEs traditional that still relies on manual and limited techniques access towards friendly technology environment .

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Based on the research gap , this study aims to For prove structure factor circular economy practices based on 5R framework in industry skin scale small Andri 99 Leather Garut through quantitative methods . This study is in detail special investigate whether the five 5R principles can join form One comprehensive circular economic system as description practice operations that focus on sustainability . It is hoped that the results of this study will give donation empirical For development measurement of the circular economy in the MSME sector , as well as become base For manufacturing mentoring policies and strategies greater sustainability effective for industry small based crafts .

THEORETICAL BASIS

Circular Economy

Circular economy (CE) is a stressed economic system efficiency use of resources through closed material cycle , different from the linear model of take – produce – dispose which results in waste high . Principle CE operations are formulated into 5R, namely Reduce (material and energy efficiency), reuse (use of recycle or return the product to the chain production), recycle recycling and sorting of materials), recovery (recovery mark remainder production become a source of energy), as well as redesign (designing rework the product to be modular and supportive longer material circulation). Implementation of 5R becomes foundation transition more industry resource- efficient and minimal waste oriented United *Nations Environment* Program Programme (UNEP, 2023)

Dimensions relevant to the circular economy variable according to, (Kirchherr & Hekkert, 2022), (Geissdoerfer & Soufan, 2023): 1. Reduce Reducing waste and resource use. 2. Reuse Reusing leftover materials or old products. 3. Recycle Recycling materials so they can be used again. 4. Recover Retrieving energy or materials from production waste. 5. Redesign Redesigning products to be environmentally friendly and resource efficient. In developments in this field , the literature about the circular economy show existence diverse perspective about structure 5R practices . Several studies have seen reduce, reuse, recycle, recover, and redesign as independent and applicable elements in a way separate , especially in industry big with system complex production (Ceddia & Sedlacek, 2024). On the other hand , other studies emphasize that fifth These principles are interrelated and form One system practices that cannot be separated , especially in the context of business small and limited in terms of resources and (Kirchherr & Hekkert, 2022)technology . Variations This view shows importance do testing empirical For ensure whether 5R practices in the industry small and medium enterprises (SMEs) leather multidimensional or integrated as One circular economy construction , so that the application of Confirmatory Factor Analysis (CFA) becomes very relevant (Hair & Sarstedt, 2021).

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Economic Sustainability

Economic sustainability refers to a stable business growth pattern without damaging environmental carrying capacity and continuing to provide social benefits across generations. Its dimensions include: economic (consistent business income), social (equal distribution of business opportunities and benefits), and environmental (ability to manage production waste). Sustainability of small industries is not only profit-driven, but must also maintain a balance of economic, social, and environmental impacts simultaneously (Todaro & Smith, 2020; UNDP Indonesia, 2024).

Identifying the causal relationship between CE and business sustainability confirms that the 5R factors can increase efficiency, reduce waste, and strengthen ESG practices in MSMEs/SMIs (Alamsyahbana et al., 2024). For quantitative research, it is better to present a theoretical framework or review of previous research. Dimensions relevant to the Sustainable Economy variable according to Todaro and Smith (2020) include: 1. Economic Sustainability 2. Social Sustainability 3. Environmental Sustainability. Previous research shows that the implementation of CE in the leather SME sector in Indonesia is still gradual and uneven. Several studies have found that CE practices are still dominated by waste reduction strategies, but are not optimal in converting waste into new sources of economic value (Rahmawati & Nanda, 2021). CE has been shown to have a positive impact on the sustainability of MSMEs, but research has mostly been conducted on general MSMEs, not the specific leather industry (Siregar, 2022).

The most recent findings show that CE is able to increase production efficiency in the range of 25–35% and contribute to increasing the income of local craftsmen, but has not assessed the 5R factors simultaneously in one analysis model (Dewi & Handayani, 2025). For qualitative research, the issues raised in the introduction must be discussed (Bell MT, 12). Based on the pattern of findings, a research gap arises in the need for quantitative studies that measure the 5R factors simultaneously and in an integrated manner, especially in leather SMEs in Garut, which has been minimally discussed in previous literature. This research places 5R (reduce, reuse, recycle, recover, redesign) as an independent variable that influences business sustainability through a logical flow: X1 X2 X3 X4 X5 X1 X3 X5 Sustainability Economy.

RESEARCH METHODOLOGY

This study employed a quantitative approach with a survey technique. Data were collected from respondents directly involved in the operational and management activities of Andri 99 Leather Garut. Data analysis was conducted using Confirmatory Factor Analysis (CFA) to test the construct validity and factor structure of circular economy practices based on the 5R framework. The use of CFA in this study focused on examining the factor structure and was not intended to examine causal relationships or influences between variables . The study location was in the Sukaregang leather industry center, Garut Regency, with the Andri 99 Leather Store

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as the case unit. This store represents a small-scale business whose production activities are carried out directly by in-house craftsmen, rather than a modern factory system. The selection of the store as the research object was aimed at ensuring that the data collected truly reflects the conditions of micro-small businesses within the regional leather industry cluster. United Nations Environment Programme (UNEP) in (Nederland & Morioka, 2021).

The operational definition of variables in this research was guided by reviewing the primary CE literature that defines 5R as the most relevant circular approach for the production chain. Five aspects of CE are placed as independent variables, including: (1) reduce, which is measured through indicators of efficient use of leather sheets, supporting materials, and reduced energy consumption; (2) reuse, referring to the return of waste materials to the assembly chain of derivative products in the store; (3) recycle, which includes the readiness to sort leather waste at the source to be processed into new inputs; (4) recover, which is the utilization of waste for alternative energy sources for production; and (5) redesign, which is product design innovation that considers easier material separation and the potential for waste recycling. The 5R framework is used because it is considered more stable and relevant in the context of SMEs, especially those that are still manual and small-scale.

The operational dimension of CE refers to the views of Geissdoerfer et al. (2023). Geissdoerfer et al. The dependent variable in this study is economic sustainability which includes dimensions of the balance of business impacts on the economy, society, and the environment. The economic dimension is measured through stable income generation, a barometer of material use efficiency, and the store's ability to reduce production costs without having to increase new material inputs. (Todaro & Smith, 2020; United Nations Development Programme Indonesia UNDP Indonesia, 2024).

The primary data scope of this study took the craftsmen directly at Andri 99 Leather as a saturated population (internal store census) to ensure no subjects were overlooked, given the relatively small population size and homogeneous data character. Saturated sampling was chosen because it can represent the conditions of the SME population as a whole without the need for generalization from only a portion of the data (Sugiyono, 2022). This method maintains the strength of internal representation, considering that the population is in a single system that does not vary extremely in terms of production models. This sampling approach was used so that researchers obtain a CE factor structure that is not biased only in a portion of the craftsmen segment. Primary data collection was conducted through a structured questionnaire using a 1–5 Likert scale to capture perceptions and habits of CE implementation. This scale spans response preferences from the lowest intensity (Strongly Disagree = 1) to the most affirmative (Strongly Agree = 5), in accordance with socio-economic survey measurement standards (Sugiyono, 2016).

Direct observations were also conducted in the store's production area to ensure the consistency of respondents' answers with daily production practices. By combining questionnaires and field observations, the collected data were not only

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statistically accurate but also contextually valid. Economic Development (Todaro & Smith, 2020). Secondary data were drawn from a review of the latest scientific literature in the CE field, industry reports, and green development regulations. The national regulatory framework that serves as a reference in the context of industrial sustainability is the 2020–2024 National Medium-Term Development Plan (RPJMN) and the derivative of Indonesia's carbon economy policy, West Java Regional Regulation No. 32 of 2009 (2009). This regulation is relevant to study in this research because it provides context for how environmental governance in large industrial clusters such as Sukaregang should operate, but has not yet addressed the equitable distribution of CE technology and literacy among micro-scale leather SMEs in Garut. This demonstrates a gap between policy, cluster readiness, and the adoption capacity of small business actors. The research instrument was processed through several testing stages.

First, the validity of the questionnaire items was tested using Pearson's Product Moment correlation (calculated r > table r, α = 0.10) in SPSS 23. Second, the reliability of respondents' answers was tested using Cronbach's Alpha (value > 0.05) to determine the internal consistency of the instrument. The reliability and validity thresholds of this research instrument refer to socio-economic research standards with structured data and homogeneous populations (Hair et al., 2021). The factor analysis conducted in this study has objective confirmatory , because structure circular economy practices that use the 5R framework has been established in a way theoretical based on studies previously . However , by paying attention to limitations on the sample size taken from one IKM unit, testing conducted using the explanatory confirmatory approach via SPSS. This method is designed For verify consistency empirical from structure 5R factors in the context of small -scale leather SMEs small as first steps to validate the construct . In addition to doing testing data feasibility using KMO and Bartlett's Test, evaluation construct also pays attention validity convergent as well as internal reliability in general conceptual past Composite Reliability (CR) and Average Variance Extracted (AVE) indicators . For further research involving sample more many , recommended For using Structural Equation Modeling (SEM) based on AMOS or SmartPLS For get index Model feasibility was assessed using the Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). The next stage of data processing used Confirmatory Factor Analysis (CFA) in SPSS 24 to reduce the indicators into the main CE factors. CFA was chosen because it is able to group strongly correlated dimensions into more efficient factor constructs without losing the basic meaning of the indicators. The feasibility of the factor model was tested using the KMO indicator (>0.5) and Bartlett's Test significance (Sig. <0.10). Rotation analysis (varimax/oblique) was used to facilitate easier reading of the factor categorization and sharper interpretation. Factor loadings or correlations between indicators were deemed feasible if they were ≥0.5. This correlation standard was used to ensure that the resulting CE factors truly emerged from statistically robust indicator relationships, not merely assumptive interpretations (Hair et al., 2021).

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The research hypothesis states that circular economy practices are based on The 5R framework (reduce, reuse, recycle, recover, and redesign) forms One structure integrated factors as circular economy construct in industry skin scale Andri 99 Leather Garut. The proof of this hypothesis is tested through a barometer of material use efficiency, the ability of waste to re-enter the derivative production chain, product design innovation, and the potential for utilizing waste as business input or alternative production energy. The results of this research are expected to provide a data-based strategic foundation, especially for small artisan education initiatives and the formulation of CE technology-leapfrog tool/partnership interventions at the SME level. The research is not directed at blaming the existing manual model, but rather at seeing how this traditional model can still be strengthened through a more targeted and measurable circular structure, so that the small micro leather industry in Sukaregang not only survives, but can be more competitive and adaptive to the long-term green industry transition.

RESEARCH RESULT

The results of the KMO and Bartlett's Test indicate that the data is suitable for factor analysis. The KMO value of 0.866 is in the very good category, which means the sample size is adequate and the correlation pattern between variables is strong enough for further extraction. In addition, the results of the Bartlett's Test of Sphericity produced a Chi-Square value of 150.923 with a df of 10 and a significance of 0.000 ($p < 0.05$), which indicates a significant correlation between variables in the correlation matrix. Thus, both results confirm that the data has met the basic assumptions of factor analysis, so the factor extraction process can be continued.

Tabel 1 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,866
Bartlett's Test of Sphericity	Approx. Chi-Square	150.923
	Df	10
	Sig.	,000

Based on the Total Variance Explained output, the extraction process using Principal Component Analysis indicates that there is only one main factor that can be retained. This is evident from the Eigenvalue value of the first component of 3.633, which is above the minimum criterion of 1, while the second to fifth components have Eigenvalues below 1 and are therefore not suitable for inclusion in the factor structure. The first factor is able to explain 72.651% of the total variance, indicating that this one factor is very dominant in summarizing information from all variables. After the extraction process, the proportion of explained variance remains at 72.651%, and there is no distribution of variance to other factors because only one factor meets the extraction requirements. Overall, these results confirm that the data can be reduced to one strong and representative main factor, with the ability to

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explain more than 70% of the data variability, so that factor analysis is considered adequate and effective for use in this study.

Table 2 Total Variance Explained

Component	Initial Eigenvalues			Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,633	72,651	72,651	3,633	72,651	72,651
2	,535	10,706	83,356			
3	,356	7,123	90,470			
4	,258	5,169	95,648			
5	,218	4,352	100,000			

Based on the results of the Component Matrix, factor analysis indicates that only one primary factor was extracted from the data. This is reflected in all variables (X1 to X5) having high factor loading values on the same component. The obtained loading values, namely 0.855 for X1, 0.815 for X2, 0.856 for X3, 0.904 for X4, and 0.813 for X5, indicate that each variable has a strong relationship to the formed factor. No variables shifted or showed a significant correlation with other factors, because only one factor was generated by the analysis. Substantively, this single factor describes one primary dimension that dominates the data structure, considering that the five variables show consistent high and unidirectional correlations with that component. Thus, this factor can be considered a core construct that comprehensively represents all variables. In conclusion, factor analysis successfully formed a dominant factor that contains all variables with very strong correlation strength, so this factor can be used as a basis for further interpretation and analysis.

Tabel 3 Component Matrix

	Component
	1
Reduce	,866
Reuse	,773
Recycle	,878
Recover	,900
Redesgin	,839

These findings indicate that The implementation of a circular economy based on the 5R framework in the Andri 99 Leather Garut leather SME is one dimension, where the whole the 5R principle works as One unity interrelated practices . This situation illustrates that the craftsmen small does not apply circular economy principles in a way separate , but rather do it simultaneously in accordance with the

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existing limitations in the production process they . The recover and recycle aspects have the most significant role , which indicates that use repeat waste production and recycling recycle material is the most possible and easiest practice applied by leather SMEs small compared to the redesign that would require further technological support .

The results of this study are in line with what was expressed by (Kirchherr & Hekkert, 2022)and (Geissdoerfer & Soufan, 2023)those who see the circular economy as a series integrated practice , instead of just a group separate activities . However , these results differ from research (Ceddia & Sedlacek, 2024)that shows that circular economy practices own characteristic multidimensional in industry large manufacturing . This difference can understood through characteristics of business size and application of technology, where the business small and medium enterprises in the sector skin tend adopt 5R principles in general simultaneously in one simple production process . In this way , the size of the business become important element in determining structure growing circular economy practices in a way real.

CONCLUSION

This study states that implementation of a circular economy based on The 5R framework (reduce, reuse, recycle, recover, and redesign) at the Andri 99 Leather Garut leather SME forms A construct interrelated and interdependent factors one dimension. This finding confirms that fifth the 5R principle is not working in a way separate , but interconnected as One unity in circular economy practices in industry skin scale small scale production methods traditional . The recover and recycle dimensions show the most significant contribution , this shows that utilization return and recycle repeat waste production is the most practical way For implementing a circular economy for leather SMEs . In general In practice , these results indicate that the strategy for developing a circular economy in the MSME sector must be designed in a way comprehensive , not just based on each dimension, and must focus attention to improvement literacy , simple technology support , and policy - based cluster industry . Thus , this study provides donation empirical to measurement of the circular economy in the MSME sector as well as become base For formulate policy sustainability that is more in line with the characteristics business small.

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