



Measuring Circularity: Metrics and Indicators for Evaluating Sustainable Business Practices

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Abstract

As businesses worldwide adopt circular economy (CE) principles, there is an increasing need for robust metrics and indicators to evaluate the effectiveness of circular practices. Measuring circularity allows organizations to track resource efficiency, waste reduction, and sustainability performance, providing insights for strategic decision-making. This research examines quantitative and qualitative circularity metrics, evaluates frameworks used across industries, and identifies best practices for measuring business sustainability. Data were collected through surveys of 60 firms implementing circular strategies and interviews with 20 sustainability managers, consultants, and industry experts. Findings indicate that material flow analysis, product lifecycle assessments, resource efficiency ratios, and circularity indicators are essential tools for monitoring circular practices, while challenges include standardization, data availability, and integration with financial performance.

Keywords: Circularity metrics, Sustainable business practices, Resource efficiency, Lifecycle assessment, Material flow, Circular economy indicators, Performance evaluation.

1. Introduction

The transition from linear to circular business models requires organizations to systematically measure and evaluate circularity. Circularity metrics help businesses:

1. **Quantify Resource Efficiency:** Understand how well materials are reused, recycled, or conserved.



2. **Track Waste Reduction:** Monitor reductions in landfill contributions and hazardous waste generation.
3. **Assess Lifecycle Impacts:** Evaluate environmental, social, and economic performance across the value chain.
4. **Enhance Decision-Making:** Inform investments in sustainable technologies, process improvements, and product redesign.
5. **Communicate Sustainability Performance:** Provide transparent reporting to stakeholders, regulators, and consumers.

Despite the growing interest, many businesses struggle with defining standardized metrics, collecting reliable data, and linking circularity indicators to financial and operational outcomes. This study explores current methodologies, evaluates practical indicators, and presents a framework for measuring circularity across industries.

2. Methodology

A mixed-methods approach was adopted for this study:

1. Qualitative Analysis:

- **Participants:** 20 sustainability managers, circular economy consultants, and industry experts.
- **Data Collection:** Semi-structured interviews exploring circularity measurement approaches, challenges, and best practices.
- **Analysis:** Thematic coding to identify key metrics, frameworks, and indicators used in practice.

2. Quantitative Analysis:

- **Participants:** 60 organizations surveyed across manufacturing, retail, FMCG, and electronics sectors.
- **Metrics Assessed:**
 - Material recovery rates (%)
 - Product lifecycle circularity
 - Waste diversion from landfills (%)



- Resource efficiency ratios (material, water, energy)
- Integration of circularity into financial reporting

3. Data Analysis Tools:

- SPSS used for descriptive and inferential statistics.
- NVivo for qualitative coding and identification of recurring themes in circularity measurement.

3. Circularity Metrics and Indicators

3.1 Material Flow Metrics

- **Recycling Rate:** Percentage of material recycled from post-consumer or post-industrial waste.
- **Reuse Rate:** Proportion of materials or components reused within the production system.
- **Material Circularity Indicator (MCI):** Composite metric evaluating how effectively materials remain in use over time.

3.2 Resource Efficiency Indicators

- **Energy Intensity:** Energy consumed per unit of product or service.
- **Water Intensity:** Water used per unit of output or per kilogram of material.
- **Waste Intensity:** Waste generated per unit of production.

3.3 Lifecycle Assessment Metrics

- **Carbon Footprint:** Total greenhouse gas emissions over product lifecycle.
- **Environmental Impact Scores:** Quantitative evaluation of resource use, toxicity, and ecosystem impact.
- **Product Longevity and Repairability:** Average lifespan and potential for maintenance or refurbishment.

3.4 Circular Business Performance Indicators

- **Revenue from Circular Products/Services:** Financial contribution of reused, refurbished, or recycled products.
- **Circular Supply Chain Coverage:** Percentage of suppliers adhering to circular principles.



- **Stakeholder Engagement:** Level of consumer and partner participation in circular initiatives.

4. Frameworks for Measuring Circularity

4.1 Material Circularity Indicator (MCI) Framework

Developed to quantify circularity at product or company level. Combines metrics of recycling, reuse, virgin material input, and product lifespan.

4.2 Circularity Gap Reporting

Assesses gaps between current material flows and ideal closed-loop flows, identifying opportunities for improvement.

4.3 Lifecycle Assessment (LCA) Approach

Evaluates environmental impacts of products or services from cradle to grave, including resource extraction, manufacturing, usage, and end-of-life management.

4.4 Triple Bottom Line Integration

Combines circularity metrics with economic, environmental, and social performance indicators for holistic business assessment.

5. Case Studies

Case Study 1: Philips Circular Lighting Initiative

- **Objective:** Implement circular product design and lifecycle tracking.
- **Implementation:** Lease-based lighting systems; components returned, refurbished, and reused.
- **Results:**
 - 40% material reuse rate
 - Reduced product lifecycle environmental impact by 25%
 - MCI score improved significantly, enhancing sustainability reporting

Case Study 2: Unilever Sustainable Packaging Program

- **Objective:** Measure circularity of packaging materials across global supply chain.



- **Implementation:** Tracking of recycled content, recyclability, and material efficiency ratios.
- **Results:**
 - 35% reduction in virgin plastic usage
 - Increased landfill diversion to 80%
 - Integrated circularity metrics into corporate sustainability dashboard

6. Data Analysis

Table 1: Adoption of Circularity Metrics in Organizations

Metric/Indicator	Firms Implemented (%)	Environmental Improvement (%)	Operational Efficiency Improvement (%)
Material Circularity Indicator (MCI)	45	20	15
Lifecycle Assessment (LCA)	50	25	18
Recycling Rate	55	22	12
Product Longevity / Repairability	35	15	10
Circular Supply Chain Coverage	30	18	12

Table 2: Drivers and Barriers for Circularity Measurement

Factor	Type	Remarks
Regulatory Reporting Requirements	Driver	Encourages formal measurement and disclosure
Consumer & Stakeholder Pressure	Driver	Increases transparency and adoption
Data Availability & Standardization	Barrier	Lack of standardized metrics limits comparability
Technological Tools	Driver	Software platforms facilitate measurement
Cost of Measurement & Reporting	Barrier	High implementation costs for SMEs
Integration with Financial KPIs	Driver	Links circularity to business performance



7. Questionnaire

1. Which circularity metrics are currently used in your organization?
2. How are material flow, recycling, and reuse tracked quantitatively?
3. What challenges are faced in data collection, standardization, or reporting?
4. How are circularity metrics integrated with operational and financial performance?
5. What frameworks (MCI, LCA, Circular Gap Reporting) are implemented, and what is their effectiveness?
6. How do consumer expectations or regulatory pressures influence circularity measurement?
7. What best practices can be shared for adopting robust circularity metrics across industries?

8. Conclusion

Measuring circularity is critical for evaluating and improving sustainable business practices. Key insights include:

- **Material Flow and Lifecycle Metrics:** Quantitative tracking of material reuse, recycling, and lifecycle impact is essential.
- **Business Performance Indicators:** Circularity metrics linked with revenue, supply chain, and stakeholder engagement provide holistic evaluation.
- **Drivers and Barriers:** Regulatory requirements, technology adoption, and stakeholder engagement enable measurement, while cost, standardization gaps, and data challenges hinder implementation.
- **Best Practices:** Integration of multiple frameworks, digital tracking systems, and alignment with financial KPIs ensures accurate, actionable, and strategic circularity evaluation.

Effective circularity measurement supports resource efficiency, environmental impact reduction, and strategic decision-making, driving organizations toward long-term sustainability and resilience.



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