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Understanding Barriers to Circular Economy Adoption: A Conceptual Study Start-up Sector of Ujjain District of Madhya Pradesh

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Abstract
Start-ups are increasingly recognized as key drivers of sustainable innovation, yet their adoption of Circular Economy (CE) principles remains limited by multiple systemic barriers. This conceptual study seeks to identify and categorize the key impediments constraining CE implementation among start-ups in Ujjain, Madhya Pradesh. Drawing on an extensive synthesis of existing literature, the study classifies these barriers into economic, managerial, and strategic dimensions that collectively restrict circular integration.A conceptual framework is proposed to illustrate the interactions among these barriers and their influence on CE readiness. The study also outlines a future research design employing Principal Component Analysis (PCA) to identify the most significant underlying factors and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method to analyze causal relationships among them. A comprehensive list of CE barriers will be developed through literature review and expert consultations.The study contributes theoretically by providing a foundational understanding of CE adoption barriers within emerging start-up ecosystems and offers a structured methodological pathway for empirical validation. Its findings are expected to inform future research and policy efforts aimed at strengthening circular transition capabilities among start-ups in regional innovation contexts such as Ujjain, Madhya Pradesh.

Keywords: Circular Economy, Barriers, Start-ups, PCA, DEMATEL, Sustainability, Ujjain.

1. Introduction

The concept of the Circular Economy (CE) has emerged as a key strategy to achieve sustainable development by promoting the reuse, recycling, and regeneration of materials in production and consumption processes. Unlike the traditional linear model of "take–make–dispose," the circular model emphasizes resource efficiency, innovation, and environmental responsibility. Start-ups, due to their flexibility and innovative capacity, have the potential to play a vital role in driving circular practices. However, the transition toward circularity is often hindered by internal managerial barriers that affect awareness, decision-making and long-term sustainability orientation.

In developing economies like India, particularly in Tier-2 cities such as Ujjain (Madhya Pradesh), the adoption of circular practices among start-ups remains limited. While global discussions on the circular economy are expanding, empirical research on managerial-level challenges in smaller regional ecosystems is scarce. Managers in these start-ups often face constraints such as lack of knowledge,

limited financial resources, short-term business focus, and absence of strategic leadership toward sustainability.

this study aims to explore and analyze the managerial barriers that restrict start-ups in Ujjain from implementing circular economy practices, thereby contributing to the growing body of knowledge on sustainable entrepreneurship in emerging economies.

2. Objectives of the Research

The following points represent the objectives of the research work:

a) To identify and categorize the key barriers hindering circular economy (CE) adoption among start-ups, with a specific focus on managerial, strategic, and institutional dimensions in Ujjain's entrepreneurial ecosystem.
b) To synthesize and integrate existing literature on CE barriers into a conceptual model that reflects interconnections between managerial awareness, leadership orientation, financial capability, and sustainability strategy.
c) To propose a theoretical framework that conceptualizes how these barriers interact to influence CE readiness within start-ups.
d) To outline a future empirical pathway using Principal Component Analysis (PCA) for identifying critical barrier dimensions and Decision-Making Trial and Evaluation Laboratory (DEMATEL) for analyzing their causal relationships.

3. Literature Review

The transition to a circular economy (CE) has garnered significant attention in various industries, driven by the need for sustainable development. However, despite its acknowledged benefits, the implementation of circular economy principles continues to face numerous barriers. This literature review synthesizes recent findings on the nature and dimensions of these barriers within different sectors, emphasizing the economic, technological, institutional, and cultural challenges that impede progress.

One major impediment to circular economy implementation is economic barriers, which are particularly pronounced in sectors like automotive and construction. (Gopan & Balaji, 2023) highlight a lack of proper economic incentives and challenges associated with guaranteeing product quality as substantial barriers in the Indian automotive sector, underscoring that financial motivations are critical in advancing circular practices (Gopan & Balaji, 2023). Similarly, (Ting et al., 2023) point to high upfront investment costs and limited funding opportunities as prominent obstacles in Malaysia's transition to circular business models, applicable across several industries, including palm oil and manufacturing (Ting et al., 2023). Within the construction sector, Wuni's classification of barriers includes financial constraints and market limitations as significant hurdles to adopting circular practices (Meng et al., 2023).

Technological and regulatory barriers also emerge as critical issues across different sectors. Grafström and Aasma (2021) classify barriers into technological, market/economic, institutional, and cultural categories, arguing that technological limitations can severely restrict progress towards a circular economy (Grafström & Aasma, 2021). This limitation is further compounded by insufficient government support and the absence of robust regulatory frameworks that govern circular practices and incentivize companies to adopt these models. Kazançoğlu et al. (2020) emphasize that a lack of supportive policies can deter businesses from pursuing environmentally friendly practices, making regulatory challenges

particularly pressing (Kazançoğlu et al., 2020). Moreover, Osei-Tutu et al. (2022) stress that understanding the complex interrelationships among various barriers is crucial for developing effective frameworks to address them in the construction industry (Osei-Tutu et al., 2022).

Cultural and institutional barriers represent another layer of complexity. Many organizations face resistance to change due to deeply rooted traditional practices that prioritize linear economic models. Bîrgovan et al. (2022) underscore that organizations must navigate organizational barriers, including cultural attitudes and the need for eco-innovation, which can hinder the incorporation of circular economy principles (Bîrgovan et al., 2022). The gap in knowledge and awareness surrounding circular economy concepts further exacerbates this issue. Many stakeholders lack the necessary understanding of what circularity entails and its benefits, leading to misalignment in efforts across various sectors. This lack of awareness, highlighted by Kirchherr et al. (2021), reveals that cultural attitudes significantly influence the acceptance of circular initiatives (Roberts et al., 2021). The interplay of these factors highlights a systemic challenge in the transition to a circular economy, necessitating a comprehensive strategy to engage various stakeholders in the process.

In conclusion, the literature reveals that advancing circular economy practices is multifaceted, involving interrelated barriers spanning economic, technological, institutional, and cultural dimensions. Addressing these challenges requires a concerted effort from all stakeholders, including policymakers, businesses, and the broader communities, to devise integrated solutions that promote knowledge sharing, establish robust regulatory frameworks, and align economic incentives with circular practices. Only through such collaborative approaches can the vision of a circular economy materialize effectively.

The following points represent the gaps in the research:

a) Limited focus on managerial-level barriers affecting circular economy adoption in start-ups.
b) Insufficient research on circular economy adoption in Tier-2 and Tier-3 cities such as Ujjain.
c) Lack of integrated conceptual frameworks linking economic, managerial, strategic, and institutional barriers.
d) Absence of studies exploring the interrelationships and causal linkages among CE barriers.
e) Minimal application of quantitative analytical tools like PCA and DEMATEL to examine CE barriers systematically.
f) Lack of empirical and contextual evidence from developing economies and regional start-up ecosystems.
g) Limited understanding of how managerial awareness, leadership orientation, and financial priorities jointly influence CE readiness.

4. Solution Methodology

This study proposes a structured, three-phase solution methodology to investigate and analyze the barriers to circular economy (CE) adoption in start-ups located in Ujjain, Madhya Pradesh. The approach integrates qualitative identification and quantitative validation using Principal Component Analysis (PCA) and Decision-Making Trial and Evaluation Laboratory (DEMATEL).

The methodological process is designed to achieve two goals:

a) Identify and group the principal barriers influencing CE adoption.
b) Examine the interrelationships and cause–effect dynamics among these key barriers.

Phase I – Identification of Barriers

In the first phase, a comprehensive list of barriers will be developed through the following steps:

a) **Literature Review (LR):** Barriers will be extracted from existing scholarly publications, reports, and policy documents related to circular economy adoption, sustainability management, and start-up ecosystems.
b) **Expert Consultation:** Inputs will be obtained from academicians, CE researchers, and industry professionals from Ujjain's start-up ecosystem to validate and supplement the list of barriers.
c) **Finalization of Barrier Set:** The consolidated list will include economic, managerial, strategic, institutional, and technological barriers.

This combined approach ensures both **academic rigor** and **practical relevance** of the identified barriers.

Phase II – Application of Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is a multivariate statistical technique used to reduce large datasets into smaller sets of interrelated components without significant loss of information. In this study, PCA will be applied to:

a) Identify principal components (groups of related barriers) influencing CE adoption.
b) Eliminate redundancy among variables by finding underlying patterns and correlations.
c) Determine the most significant dimensions—for example, managerial, financial, strategic, or institutional barriers.

Each barrier (variable) will be rated through structured questionnaires distributed to start-up managers and sustainability experts. PCA will help in identifying the key constructs that explain maximum variance, thus simplifying complex barrier data into interpretable factors.

Mathematically, PCA transforms correlated variables (X_1, X_2, …, X_n) into uncorrelated principal components (Y_1, Y_2, …, Y_m) using linear combinations, where (Y_1) accounts for the highest variance.

This step provides the foundation for causal relationship analysis using DEMATEL in the next phase.

Phase III – Application of Decision-Making Trial and Evaluation Laboratory (DEMATEL)

Once the principal components are extracted through PCA, the DEMATEL method will be used to analyze interrelationships among these components.

DEMATEL is a decision-making and systems analysis technique that helps identify cause–effect relationships among factors within a complex problem. It transforms qualitative expert judgments into a visual causal diagram, showing which components influence others (cause group) and which are affected (effect group).

Steps in DEMATEL application include:

a) Constructing a direct-influence matrix based on expert evaluations of how one component affects another.
b) Normalizing the matrix and computing total influence values.
c) Identifying cause and effect groups based on threshold values.
d) Developing a cause–effect diagram (impact-relation map) to visualize the structural relationships among barriers.

This analysis helps decision-makers understand which barriers are root causes (e.g., lack of managerial awareness or weak leadership) and which are resulting effects (e.g., financial or strategic planning issues).

Together, PCA and DEMATEL offer a comprehensive analytical process:

a) PCA simplifies and identifies the key components (what to focus on).
b) DEMATEL establishes how these components influence each other (how to act on them).

Table 4.1 portrays the details of different methods along with their applications in solution methodology.

Table 4.1: Different Methods along with their Applications in Solution Methodology

Phase	Purpose	Tool Used	Outcome
Phase I	Identify all barriers (academic + practical)	Literature Review & Expert Input	Comprehensive list of CE barriers
Phase II	Group and reduce barriers into key dimensions	PCA	Principal components (core barrier categories)
Phase III	Analyze causal relationships among these components	DEMATEL	Cause–effect model for CE adoption barriers

5. Conclusion and Future Scope of the Research

The present conceptual study provides an in-depth understanding of the barriers that hinder the adoption of Circular Economy (CE) practices among start-ups in Ujjain, Madhya Pradesh. While start-ups are often characterized by innovation and flexibility, their transition toward circular business models is constrained by a combination of managerial, financial, strategic, and institutional challenges. The study emphasizes that these barriers are not isolated but interdependent, collectively influencing the readiness of start-ups to embrace sustainable practices.

By synthesizing insights from existing literature and contextualizing them within Ujjain's emerging entrepreneurial ecosystem, this research highlights a significant gap in understanding CE adoption at the regional and managerial level. The proposed conceptual framework and future methodological plan—integrating Principal Component Analysis (PCA) and Decision-Making Trial and Evaluation Laboratory (DEMATEL)—offer a structured pathway for empirical investigation. PCA will serve to identify the most influential underlying components among various barriers, while DEMATEL will elucidate the cause–effect relationships between these factors, enabling a systemic understanding of how managerial and strategic decisions affect circular transition readiness.

Theoretically, the study contributes by extending the discourse on circular economy adoption to the context of Tier-2 cities and start-up ecosystems in developing economies, where managerial awareness and institutional support remain limited. Practically, it provides a roadmap for policymakers, incubators, and start-up support organizations to design targeted interventions—such as training programs, financial incentives, and leadership development initiatives—that can strengthen circular capabilities at the grassroots entrepreneurial level.

In conclusion, the paper lays a conceptual foundation for future empirical research on circular economy barriers and emphasizes the need for collaborative efforts between academia, industry, and government to enable sustainable transformation in start-up ecosystems. By advancing understanding in this underexplored domain, the study aspires to contribute to the broader agenda of sustainable development and resource efficiency in India's regional innovation landscape.

Future research should empirically validate the proposed framework by collecting primary data from start-ups and stakeholders in Ujjain and similar regional ecosystems. The application of PCA and DEMATEL will help identify actionable managerial priorities and causal relationships, ultimately

guiding strategic interventions to accelerate the adoption of circular economy practices across emerging entrepreneurial hubs.

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