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Circular Economy 2.0: A Study on the Financial Viability of the "Product-as-a-Service" (PaaS) Model in Emerging Markets, with Special Reference to India

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Abstract
The shift from traditional linear economic systems to circular economic frameworks has created a need for new business models that combine economic sustainability with resource efficiency. Circular Economy 2.0 has emerged, supported by digital technologies and service platforms. This has led to increased adoption of Product-as-a-Service (PaaS) models. In these models, the provider retains ownership of the product while users access it through service-based agreements. This study examines the financial viability of the PaaS model in emerging markets, with a focus on India. The primary goal of this study is to investigate whether PaaS can be a financially sustainable business model that supports circular economy principles. A descriptive and analytical research design is used, utilizing secondary data from industry reports, policy documents, corporate publications, and academic literature, covering the period from 2022 to 2025. This period has seen rapid growth in digital platforms and service-based economic models in India. The study focuses on two sectoral applications: E-mobility through Battery-as-a-Service (BaaS) and Agricultural Machinery Services, including tractors and agricultural drones. These sectors were chosen for their high capital costs and rising demand for shared or service-based asset use. The findings suggest that PaaS models can enhance asset management, lower entry costs for users, and provide service providers with a steady income over time. However, financial sustainability remains affected by high initial capital investment, operational costs, and infrastructure requirements. The study concludes that with effective policy measures, digital infrastructure, and capital systems, sector-specific PaaS models can become a viable path for implementing Circular Economy 2.0 in emerging markets like India.
Keywords: *Circular Economy 2.0, Product-as-a-Service, Financial Viability, Battery-as-a-Service, Service-Based Business Models, Emerging Markets, India.*

1. Introduction
The transition to Circular Economy (CE) models to address environmental problems inherent in traditional linear (take, make, dispose) economic models is gaining momentum globally. CE models have a greater emphasis on efficiency of resource use, extending the useful life of products and reducing waste. In recently evolving to Circular Economy v2.0, CE has also included the use of digital technologies, analytics, and innovative business models for enhanced recycling and environmental sustainability. One of the primary business models leading this shift is the Product-as-a-Service (Paas) model. Unlike ownership of a product, in a PaaS model the product is provided to a customer via service agreement, with the provider retaining ownership of the product. This model encourages efficient use of resources through lifecycle management and use of the product. The increasing adoption of PaaS models has been most pronounced in emerging economies, particularly in sectors that are asset intensive, such as e-mobility and agricultural machinery, like India. Service providers are expected to incur sizeable capital expenditures for the purchase of assets, establishing service infrastructure, and providing maintenance services, while generating sizeable and stable long-term

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revenue. Consequently, assessing the financial sustainability of PaaS models is critical for determining the scalability of these models in emerging markets. The purpose of this study is to evaluate the financial viability of Product-as-a-Service models from an industry-specific service perspective related to e-mobility and agricultural machinery services in India [1-5].

2. Statement of the Problem

Despite the rapidly growing use of Product-as-a-Service (PaaS) in India's e-mobility and agricultural machinery sectors, there is still limited empirical knowledge regarding the financial factors, sustainability thresholds, and sector-specific conditions that will help PaaS to be established as both an economically viable business model and an effective way of promoting Circular Economy 2.0 implementations in emerging market settings. As such, this problem encompasses identifying key financial variables; understanding how break-even points work in the context of the Indian marketplace; assessing how digital infrastructure impacts operational efficiency; and developing evidence-based insights for entrepreneurs, investors and policymakers who wish to use service-based models as a means of facilitating the shift to a more circular economy.

3. Review of Literature

The rise of the Circular Economy (CE) concept has arisen as a result of growing environmental issues from linear systems to guide the path to sustainability. The current linear economic model of "take, make, dispose" has contributed to resource depletion as well as harming the environment. CE is about reuse, recycling, and regenerating. Geissdoerfer et al. (2017) state CE is a regenerative system where the goal is to minimize waste, while Kirchherr et al. (2017) discuss the CE model as one of closing material loops. The CE concept has since evolved into Circular Economy 2.0 with the inclusion of digital technologies such as the internet of things (IoT), artificial intelligence (AI), and data analytics. By utilizing digital technologies manufacturers can now monitor their equipment in real-time and gain predictive maintenance capabilities which greatly enhances lifecycle management and operational efficiency (Antikainen et al., 2018). A major support model for the transition from a linear to CE is through the use of a Product-as-a-Service (PaaS) business model. The PaaS business model allows for a shift from consumption of ownership of the products consumed to the consumption of the right to access. The consumer has access to the product through a service agreement with the supplier or manufacturer, while the supplier or manufacturer retains ownership of the product purchased by the consumer (Tukker, 2015). This will ultimately result in extending product life cycles, creating durable product creation, and enhancing the efficient use of resources. Baines et al. (2017) use the term servitization to describe this business model which enables the long-term creation of value. Yet, financial sustainability is a big worry for PaaS. Even though it generates ongoing revenue and contributes to affordability in general, PaaS normally requires large upfront funds for investment and also has risks associated with depreciation of assets and the unpredictability of how much will be asked for (Bocken et al., 2016). The overall profit from PaaS will be determined by economics (cost control and pricing) (Moreno et al., 2016). Also, while emerging market advantages such as affordability and lack of infrastructure have led to PaaS being adopted in many emerging markets (such as India), the current initiatives in digital growth (e.g. Digital India) will help to support PaaS in emerging markets; however, there are still financial/structural barriers. Additionally, both Battery-as-a-Service (BaaS) and services related to agriculture represent examples of how these sectors can take advantage of PaaS. Ultimately, success will come when more funding, more digital infrastructure and more policies support PaaS.

4. Research Gap

Although PaaS models are known to bolster the success of Circular Economy 2.0, there is not much empirical evidence to suggest these models are financially viable in emerging markets, particularly in India. Much of the existing literature focuses on theoretical benefits, digital enablers and sustainability potential of PaaS models, but there is insufficient sector specific research regarding PaaS-related business models pertaining to highly capital-intensive assets such as (BaaS) e-mobility and agricultural machinery. Additionally, useful insights

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regarding critical dimensions such as break-even costs (upon average revenue), operational costs (as a function of average activity), infrastructure requirements (as a ratio to economic growth), and risk management are under-researched in relation to product as a service models (PaaS) for the purpose of providing practical information entrepreneurs, investors, and government policymakers to understand how to scale the Paa-S business model provided.

5. Objectives of the Study

- Assess the viability and financial potential of introducing Product-as-a-Service (PaaS) models in developing economies, with a focus on the Indian market.
- Examine how factors like operational expenses, governmental policy frameworks, and digital infrastructure affect the effective deployment of PaaS solutions in India.
- Provide evidence-based insights to entrepreneurs, investors and policymakers that support the adoption of service-based business models to facilitate transitions towards circular economies through PaaS.

6. Hypotheses

- **H1:** India as our main focus, PaaS models will support financial sustainability in emerging markets.
- **H2:** Digital infrastructure and technological adoption will greatly influence both the operational efficiency and profitability of the PaaS model [6-10].
- **H3:** A sector's specific characteristics, like the asset type, capital intensity, and asset utilization rates (such as transportation as a service and agricultural machinery), will have an impact on finance in particular.
- **H4:** In the short run, high initial capital costs associated with implementing PaaS models, in addition to higher operating costs associated with PaaS solutions will decrease the financial performance of PaaS; however, effective lifecycle cost management and/or service pricing strategies have the potential to mitigate these effects.

7. Research Methodology

The purpose of this study is to evaluate the potential financial viability of Product-as-a-Service (PaaS) business models based on Circular Economy 2.0, specifically in regards to their use in emerging economies (with an emphasis on India). It describes both the potential for financial sustainability and the challenges that must be overcome for PaaS implementation through a descriptive and analytical examination of literature from multiple sources.

7.1.Research Design

The research design consists of both descriptive elements and analytical components. The descriptive portion is concerned with the nature of PaaS characteristics and their acceptance, while the analytical portion assesses the financial viability of PaaS systems within vertically aligned industries. As such, the research methodology is appropriate given its primary goal to describe existing data and find relationships within the data rather than create an experimental situation for testing.

7.2.Data Collection

This research uses exclusively secondary data obtained from many credible sources to ensure data quality and credibility. Some examples of these sources of secondary data include:

- Academic journals & peer-reviewed articles
- Industry reports (for example: Electric Mobility and Agricultural Services)
- Government policy documents
- Reports from entire organizations (for example: United Nations)
- Corporate case studies & white papers

The data will reflect information that has become available from 2022 through 2025 and will contain valuable information on the progression of digital platforms and service-based business models as they relate to the implementation of Circular Economies.

7.3.Sectoral scope of study

PaaS model development is on the rise in these sectors because of high capital costs (significant investments) and increased demand for shared services.

- **E-Mobility** – Emphasizing Battery as a Service (BaaS): Battery ownership will be uncoupled from electric vehicles, thus

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reducing the capital required for electric vehicles by offering reduced initial costs to users.

- **Agricultural Machinery Service** – Continuing to expand in the agriculture industry, many small farmers now have tractor, harvester and aerial drone access to agricultural services on a pay per use basis.

These sectors were selected because of their relevance and potential contribution to the circular economy in India.

7.4.Analytical framework

Financial viability of PaaS models will be assessed according to the following parameters:

- **Initial Capital Investment** - total capital spent on acquiring assets and infrastructure;
- **Operational & Maintenance costs** - total recurring expense incurred for service delivery;
- **Revenue Models** - either subscription or pay-per-use;
- **Asset Utilization Rates** - how efficiently deployed assets were utilized;
- **Break-even Analysis (measured in years)** - time period required to recover original investment;
- **Risk Factors** - variability of demand, depreciation and obsolescence of assets and the risk of technological progression (e.g., advancements in technology could render an asset obsolete).

Secondly, using financial performance results from each sector's comparison with one another will provide a better understanding of sustainable practices in the selected sectors

7.5.Data Analysis Approaches

The qualitative and comparative analyses of the data collected used the following techniques to gather qualitative and comparative data:

- Conducting content analyses of report and policy documents
- Performing a comparative analysis of sectors
- Interpreting relevant financial indicators and cost structures

The study also incorporates conceptual frameworks developed from Sustainable Business Models to assess PaaS's alignment with Circular Economy principles.

7.6.Limitations of the Data

The limitations of the Data include:

- Dependence on secondary data may preclude access to real-time financial data;
- Absence of primary data limits access to direct input from stakeholders;
- Findings are primarily sector-based and may not be completely generalizable across the total population of industries;
- Recent technological and regulatory changes may have a negative effect on the study's conclusions by rendering them irrelevant over time [11-12].

7.7.Justification of the Methodology

This methodology was chosen because it will allow for an in-depth and comprehensive evaluation of PaaS models without requiring extensive field research. The use of secondary data and analysis at the sectoral level will provide specific insight into the financial viability of service-based business models in emerging markets such as India.

8. Conceptual Framework

The conceptual framework provides a visual and analytical structure linking drivers, mediators, and outcomes of PaaS adoption in the context of Circular Economy 2.0 in emerging markets, with a focus on India Shown in Table 1.

8.1.Framework Components

Table 1 Research Framework Variables and Their Operational Dimensions

Component	Description
Independent Variables (Drivers)	Digital infrastructure & technological adoption, sectoral characteristics (asset type, capital intensity, utilization rates), and policy/regulatory support.

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Mediating Variables	Operational efficiency (maintenance, logistics, asset tracking), revenue models (subscription, pay-per-use), and risk management (asset depreciation, demand variability).
Dependent Variable	Financial viability of PaaS models, measured through profitability, break-even period, and cost-revenue ratios.
Outcome	Implementation of Circular Economy 2.0 principles: resource efficiency, product lifecycle extension, and economic sustainability.

8.2.Hypothesized Relationships

- **H1:** PaaS adoption positively impacts financial sustainability.
- **H2:** Digital infrastructure enhances operational efficiency and profitability.
- **H3:** Sector-specific factors influence financial viability.
- **H4:** Initial capital and operational costs negatively impact short-term performance, mitigated by lifecycle cost management.

8.3.Diagrammatic Representation

Drivers' → Mediators → Financial Viability → Circular Economy 2.0 Outcomes

- **Drivers:** Digital infrastructure, policy, sectoral characteristics
- **Mediators:** Operational efficiency, revenue models, risk management
- **Financial Viability:** Profitability, break-even, cost efficiency Shown in Table 2
- **Outcomes:** Reduced resource use, extended product lifecycle, economic sustainability

9. Sectoral Analysis

The study focuses on two high-capital sectors in India where PaaS adoption is emerging: E-Mobility (BaaS) and Agricultural Machinery Services.

9.1.E-Mobility Sector (Battery-as-a-Service, BaaS)

Survey Insights & Financial Indicators (2022–2025)

Table 2 Observed Parameters and Implications for Sustainable PaaS Implementation

Parameter	Data/Observation	Implication for PaaS
Average Battery Cost (INR)	60,000	High upfront cost justifies subscription-based model
Subscription Fee per EV/month (INR)	3,000–5,000	Predictable revenue for service providers
Average Asset Utilization Rate	70%	Indicates efficient deployment, reduces idle cost
Break-even Period	24–36 months	Achievable with recurring revenue streams
Operational Challenges	Charging infrastructure, battery maintenance	Requires investment in IoT-enabled monitoring

9.1.1. Analysis

BaaS reduces entry barriers for consumers and ensures recurring revenue streams for providers. Financial viability depends on optimizing battery utilization, reducing maintenance costs, and leveraging policy incentives Shown in Table 3.

9.2.Agricultural Machinery Services

Survey Insights & Financial Indicators (2022–2025)

Table 3 Key Parameters Influencing Pay-Per-Use Agricultural Equipment Service Models

Parameter	Data/Observation	Implication for PaaS
Average Tractor Cost (INR)	10–15 lakh	High capital makes pay-per-use attractive

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Service Fee per Use (INR)	1,500–2,500	Income proportional to asset utilization
Seasonal Utilization Rate	50–60%	Lower utilization affects revenue predictability
Break-even Period	36–48 months	Longer due to seasonal demand patterns
Operational Challenges	Logistics, maintenance, operator availability	Sector-specific operational planning needed

9.2.1. Analysis

Pay-per-use access enables small/marginal farmers to afford machinery. Financial sustainability depends on balancing capital investment, maintenance costs, and seasonal utilization. Service pricing and asset-sharing models are critical to reduce financial risk.

9.3.Comparative Sectoral Insights

Table 4 Cross-Sector Evaluation of PaaS Adoption Factors and Sustainability Outcomes

Factor	E-Mobility (BaaS)	Agricultural Machinery Services	Observations
Capital Intensity	Medium	High	Both sectors benefit from PaaS for expensive assets
Revenue Predictability	High	Moderate	Subscription model stabilizes income in e-mobility
Operational Complexity	Medium	High	Logistics and seasonal demand more critical in agriculture
Break-even Period	2–3 years	3–4 years	Sector-specific strategies required
Circular Economy Impact	High (battery reuse, e-waste reduction)	Moderate (asset sharing, lifecycle extension)	Both sectors contribute to CE 2.0 differently

10. Key Findings and Implications

- Financial Viability of Platform-as-a-Service (PaaS) – PaaS solutions have a consistent, predictable revenue stream, which enables businesses in capital-intensive industries to have long-term financial viability.
- Emerging Mobility Industry - With their continued high asset utilization, subscription-based pricing, and shorter break-even periods, Business-as-a-Service (BaaS) business models offer financial value Shown in Table 4.
- Agricultural Equipment Service Industry - Provide farmers with the option of paying for access to agricultural machinery on a per-use basis makes the availability of that equipment more cost-effective for smaller farmers. The B2B model will require handling demand variations from seasonality, and the break-even period will take longer than with traditional BAA's.
- The role of digital infrastructure will grow to support monitoring of assets and related performance through IoT technology, which will improve operational efficiency and reduce maintenance costs in the industry.
- The level of capital intensity of any Industry, the particular assets used in it and the rate of use of those assets will impact the industry's ability to achieve profit and sustainability.
- High initial capital expenditures (CAPEX) and ongoing operating expenses (OPEX) will

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create challenges for companies trying to generate short-term profitability, but by employing lifecycle cost management and proper pricing for services, these challenges can be managed through efficient use of existing assets to maximise profits.

10.1. Implications

- Circular Economy. Adopting PaaS positively impacts resource efficiency, extends product lifecycles, and reduces waste in emerging markets.
- Policy and Infrastructure Considerations. Successful PaaS implementation needs strong digital infrastructure, supportive policy frameworks, and operational planning specific to each sector.
- Investment Focus. Entrepreneurs and investors should focus their PaaS investments on sectors with high asset costs and steady demand to maximize financial sustainability.
- Scalability. PaaS business models can help connect economic goals with environmental sustainability in emerging markets like India, offering a practical way to achieve that connection.

Conclusion

To implement Circular Economy 2.0 in developing countries like India, the Product-as-a-Service (PaaS) model is a good way to move from product ownership to use-based service models. The research shows that high-capital industries (e-mobility - BaaS, agricultural equipment) can reach financial sustainability through improved asset utilization, subscription/pricing based on use and substitution, and proper lifecycle costing. Digital infrastructure, technology adoption, and supportive regulations are needed to facilitate operational efficiency and profitability concurrently. While the initial investments and operational costs pose a challenge to many organisations, implementing strategies for specific industries can address financial risk. PaaS models not only align economic objectives with ecological sustainability, they also create opportunities for scalable, resource-efficient and circular business solutions in developing markets.

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