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International Journal of Innovation Studies

IMPACT OF ECO-FRIENDLY STARTUPS IN SUSTAINABLE DEVELOPMENT IN INDIA

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Abstract

It is essential to comprehend how entrepreneurs implement the idea of sustainability in a variety of contexts, such as social, political, and complex orders. Being receptive to ideas about the economy, society, and environments such as sustainability—is crucial. A flexible framework for the sustainability industry. The number of classes in the International Patent Classification indicates the growth potential of the sustainability sector, which is reflected in the variety of patterns that the sector exhibits. Connected technologies fall into three categories: Older, more fundamental technologies have become less meaningful, while consumer-oriented technologies are leading the way in the latest sustainability trends among entrepreneurs. By addressing environmental issues and advancing sustainable practices, green startups are essential to sustainable development. These new businesses use creativity, technology, and dedication to environmental responsibility in order to develop ideas that support a sustainable future. An excellent way to improve the present and the future is through green startups. For the benefit of present and future generations, these startups create cutting- edge technologies that safeguard the environment and strengthen national economies.

Keywords. Eco-friendly, Sustainable development, startups, technology, Innovation, Environment

Introduction:

These environmentally conscious startups have a big, co mb i n ed impact because they fight climate change, protect natural resources, and create a sustainable global economy.

Through innovation and dedication

to ecologically conscious business practices, all industries are being transformed and heading toward sustainability. Because environmentally friendly businesses solve environmental issues, inspire creativity, and effect positive changes, sustainable growth is significantly increased. There are multiple ways to observe the impact.

Preservation of the Environment

Resource Efficiency: Sustainable businesses frequently concentrate on developing goods and services that encourage recycling, use less resources, and produce less waste.

Renewable Energy: By lowering reliance on fossil fuels, minimizing climate change, and promoting cleaner energy options, startups in the renewable energy industry make a major contribution.

Reducing Carbon Footprint: A lot of environmentally conscious firms concentrate on creating ways to cut carbon emissions, which helps with international efforts to slow down climate change.

Purpose of the study

The purpose of this paper is to critically examine the impact of eco-friendly startups on sustainable development in India. It reviews how these ventures contribute to environmental preservation, resource efficiency, and renewable energy adoption, while analyzing their innovative business models across sectors such as agriculture, transportation, and construction. The study also aims to identify and discuss the main barriers and challenges faced by eco-friendly startups, including issues related to funding and regulatory frameworks. By synthesizing insights from literature and case studies, the paper highlights the importance of technology and collaboration, and ultimately offers recommendations to strengthen the ecosystem for green startups, supporting India's transition toward a resilient, inclusive, and sustainable future.

- To review the overall impact of eco-friendly startups on sustainable development in India.
- To study the main barriers and challenges faced by eco-friendly startups.

Research Methodology:

The goal of this research, which is wholly dependent on secondary sources, is to gather as much data as possible that influences government initiatives, sustainable development, and startups. The majority of the information regarding the Indian handicraft industry has been gathered from a variety of sources, including research papers, textbooks, journals, websites, and reports.

Limitations of the study

While this study offers valuable insights into the impact of eco-friendly startups on sustainable development in India, it is primarily based on secondary data from published reports and literature, which may not fully capture recent developments or regional differences. The lack of primary data, such as direct interviews or surveys, limits the depth and real-time relevance of the findings. Additionally, the rapidly evolving nature of the green startup sector, potential publication bias, and limited quantitative analysis further restrict the scope. Contextual differences and language barriers may also affect generalizability. Future research should incorporate primary data and longitudinal analysis for deeper understanding.

Review of Literature:

Martins & Freire (2023) studied the absorptive capacity of startups during the COVID- 19 pandemic, focusing on capitalizing on competitive advantages in Edtech. This study used a qualitative approach through in-depth interviews with startup founders and industry experts to understand the adaptation strategies used by startups. The study identified key themes related to absorptive capacity that shed light on how startups face challenges and seize opportunities in unprecedented times (Martins and Freire, 2023).

Sharon and Ronen (2020) conducted a quantitative study of urban innovation in Mediterranean cities using a survey to assess readiness for sustainability. This study used a cross-sectional survey design that collects data from different cities. Statistical analysis, including regression models, was used to identify factors influencing sustainability readiness. The findings contribute to understanding the role of local governance and urban planning in promoting innovation and sustainability (Sharon and Ronen, 2020).

Hassan et al. (2022) Hasan, Ur Rahiman, Raza Rabbani and Alhomaidi used a mixed methods approach to explore the future of finance and fintech in the MENA region. The study combined quantitative analysis of financial trends with qualitative interviews with key industry stakeholders. Data triangulation strengthened the reliability of the results and provided a comprehensive picture of fintech opportunities and challenges in the region (Hassan et al., 2022).

Gupta and Rubalcaba (2021) Gupta and Rubalcaba proposed a competency-based and industry-relevant (C-IR) framework through a conceptual study. This study included a comprehensive review of existing literature on competency-based strategies and industry communication models. Developed based on iterative feedback and validation from industry experts, this framework provides a theoretical framework for sustainable business growth for startups (Gupta & Rubalcaba, 2021). Nunes et al (2022) Nunes, Morioka and Bolis used a qualitative case study approach to investigate business model challenges for sustainability in startups. Several startups were selected as cases and in-depth interviews and document analysis were conducted. Thematic analysis was used to identify recurring challenges and potential solutions, contributing practical insights for startups navigating the complexities of sustainable business models (Nunes et al., 2022). Ismail et al (2018) Ismail, Kamel and Wahba used a quantitative research design to examine the impact of technology-based incubators in emerging conomies.

We conducted a survey of startups incubated in technology hubs and statistically analyzed the data. This study used regression analysis to identify factors that contribute to the success of startups in technology- based incubators, providing valuable information for policy makers and incubator managers (Ismail et al., 2018). Nurhas et al. (2021) Nurhas, Geisler and Pawlowski developed a competency framework using an action research approach. The study involved multiple generations in a start-up environment and used qualitative methods such as focus group discussions and iterative feedback sessions. The resulting skills framework was refined through continuous collaboration with the startup team, emphasizing the importance of intergenerational collaboration for innovation (Nurhas et al., 2021). Barbulescu et al (2021) Bărbulescu, Tecău, Munteanu and Constantin studied startup innovation in the Romanian entrepreneurial ecosystem using a qualitative case study approach. We selected several startups as case studies and conducted interviews with founders and key stakeholders. Thematic analysis was used to identify innovation patterns and the role of the ecosystem in supporting or inhibiting the innovation efforts of startups (Bărbulescu et al., 2021). Kyzym et al.(2023) Kyzym, Dymchenko, Smachilo, Rudachenko, and Drill used cluster analysis to understand the conditions for implementing strategies in a country's startup ecosystem. This study used quantitative methods to rank countries according to the characteristics of their startup ecosystem. The findings provided valuable insights for decision makers and ecosystem builders, providing a systematic framework for adapting strategies to the unique characteristics

of different startup ecosystems (Kyzym et al., 2023). Abbas and Liu (2022) Abbas and Liu investigated lean eco-innovation organizations in lean startups in emerging economies. The study used a qualitative approach, including conducting in-depth case studies of several startups. Thematic analysis has been used for diagnosis and challenges in the context of lean eco-innovation, providing nuanced insights to startups navigating resource constraints (Abbas & Liu, 2022).

Flynn (2018) Flynn proposed the DIVE-IN method for building problem-first teams in entrepreneurship education. This study used a mixed-methods design combining qualitative interviews with teachers and quantitative assessments of student performance. The iterative development of the DIVE-IN framework included a continuous feedback loop that contributed to a practical and experiential approach to team building in entrepreneurship education (Flynn, 2018). Jabeen & Bodolica (2023) Jabeen and Bodolica investigated the transformation of methanol from a lethal crop to a valuable resource through a qualitative case study. The research included interviews with industry experts, politicians and environmentalists. Thematic analysis was used to map the evolution of perceptions and practices regarding methanol, contributing to the discourse on sustainable resource use (Jabeen & Bodolica, 2023).

Cukier et al. (2016) Cohn and Lyons explored the evolution of the software startup ecosystem through a longitudinal case study in New York City. This study used a mixed- methods approach combining quantitative startup data analysis and qualitative interviews with key players in the ecosystem. Data triangulation provided a comprehensive understanding of the factors influencing the growth and evolution of the software startup ecosystem (Cukier et al., 2016).

Boldyrieva et al. (2022) Boldyrieva, Alizada, Grishko and Khunchenko discussed construction management based on European experience with smart city technologies. This study used a qualitative method based on case studies of European smart city construction projects. Thematic analysis was used to identify best practices and challenges in integrating smart city technologies into construction management, contributing insights for the widespread adoption of these technologies (Boldyrieva et al., 2022).

Working Area of Start-ups

To fulfil its mission of sustainable development, the startup works in the following directions:

- Renewable Energy Solutions: Utilizing clean, renewable energy sources like solar, wind, hydro, and geothermal energy is the main goal of startups in the renewable energy sector. These programs lessen greenhouse gas emissions, lessen our reliance on fossil fuels, and aid in the shift to a sustainable energy infrastructure.
- Circular economy practices: Startups promote the concept of circular economy by developing products and services that minimize waste and encourage reuse and recycling of materials. Initiatives such as zero-waste packaging, sustainable fashion and recycling technologies are helping to reduce the environmental impact of existing network economy models.
- Smart farming and food technology: Organic farming startups use technology to optimize farming practices, reduce resource use and reduce environmental impact.

 Sustainable agriculture startups often focus on precision agriculture, agricultural technology solutions, and organic farming to promote food security while reducing environmental impact.

 Green transportation: Transportation startups are developing innovative and sustainable alternatives to traditional fossil fuel vehicles.

 Electric vehicles, bike sharing programs and public transport plans can help reduce air pollution and CO2 emissions.

 Water conservation and management: Startups are addressing water scarcity by developing technologies for efficient water use, treatment and management. Solutions range from smart agricultural irrigation systems to water treatment technologies that provide clean and safe drinking water.

 Environmental monitoring and conservation: Green startups use technology to monitor and conserve the environment. Satellite imagery, sensor networks, and data analysis are used to track deforestation, monitor air and water quality, and support conservation planning.

 Green Buildings and Sustainable Construction: Startups in the construction industry are focusing on sustainable building materials, energy efficient design and green building practices. These initiatives contribute to reducing the environmental impact of the built environment, increasing energy efficiency and reducing waste.

 Educational initiatives: Some startups focus on raising awareness and educating individuals and companies about sustainable practices.

Eco-friendly Start-ups and Their Working in India

Renewable energy: There is an increasing amount of interest in startups that use renewable energy sources like geothermal heat, hydropower, wind, and solar power. Energy storage, grid optimization, and distributed energy solutions have all made significant strides. A growing number of businesses are implementing circular economy models, which give recycling and waste minimization top priority. Startups have created creative methods for reducing waste, recycling materials, and designing products. Agriculture that is sustainable: Agricultural startups have concentrated on precision agriculture, agricultural technology solutions, and sustainable farming practices in an effort to lessen their adverse environmental effects. These included resource- efficient technologies, organic farming, and vertical farming. Zero waste and plastic substitutes: In order to combat the issue of single-use plastic, startups have introduced biodegradable substitutes, encouraged the use of reusable products, and created creative packaging that has a lower environmental impact.

Clean Transportation: Electric Vehicle Operators Clean Transportation: Businesses creating electric cars, alternative fuels, and sustainable transportation plans are becoming more and more well-liked. This includes brand-new initiatives focused on the advancement of public transportation, bicycles, scooters, and electric cars.

Green construction and building: New businesses are starting to appear with products and technology aimed at lessening the environmental effect of building projects. These included energy-efficient building techniques, sustainable architecture, and smart building technologies. Water efficiency, treatment, and conservation technologies: As worries about water scarcity increase, startups are creating technologies to deal with these problems. This covers upgrades to water treatment, monitoring systems, and leak detection.

Eco-friendly Startups Trying to Clean -up and Greener India's Future

FIGURE 1. Eco-friendly Startups Trying to Clean -up and Greener India's Future (Source: https://inc42.com/features/cleantech-startups-that-offer-sustainable-lifeways-without-compromising-on-growth/)

- Orb Energy: Solar energy is a cheap and environmentally friendly energy source that Orb Energy wants to help SMEs use! They authorize loans to commercial and industrial clients for the installation of rooftop solar power systems without the need for collateral. To date, Orb Energy has raised more than $13.6 million in investment.
- Nepra: "Zero Waste to Landfill" and "Closing the Loop," which establishes a circular economy, are Nepra's mottos. Nepra Resource Management Private Limited operates five material recovery facilities in India, each with a daily capacity of 560 metric tons. Nepra has already collected more than $24.5 million in investment.
- GPS Renewables: The goal of Green Power Systems (GPS) renewable energy is to efficiently transform trash into energy. The cities have been powered by these fully automated and artificial intelligence (AI) driven waste-to-energy systems. More than $23 million in investment has been raised by GPS Renewables.
- Devic Earth: Devic Earth hopes to protect millions from air pollution with Operation Pure Skies. At the moment, they service 20 million square meters in more than 25 sectors. Devic Earth has amassed more than $1.36 million in investment.
- D&D Ecotech: The authority in rainwater harvesting is D&D Ecotech! To store rainwater and replenish groundwater, they employ the greatest rainwater harvesting management systems that they have planned, built, and put into place.
- Digital Green: With the aid of technology and grassroots collaborations, Digital Green seeks to uplift and empower smallholder farmers. To guarantee that farmers have the finest resources to produce the highest quality crop, they create an environment that is inclusive, climate resilient, and nutrition-sensitive.
- Zunroof: Zunroof wants to introduce solar power into homes. They have designed, installed, and maintained solar rooftop systems, enabling residences in more than 75 Indian cities to run entirely on solar electricity. To date, Sunroof has raised more than $4,7 million in investment.

 Ace Green Recycling: An effective and hygienic method for recycling lead-acid batteries has been created by Ace Green Recycling. Their batteries have zero air emissions and waste, run at room temperature, and significantly lessen environmental harm from heavy metal emissions. To date, Ace Green Recycling has raised more than $10 million in funding.

 Chakr Innovation: The goal of Chakr Innovation is to lower the amount of particulate pollution in the atmosphere. It employs approximately 80% of particulate matter emissions that are captured at the source to create valuable materials. To date, Chakr Innovation has raised more than $3 million in funding.

 Offgrid Energy: The goal of Offgrid Energy Labs is to provide battery technology solutions that are safe, affordable, and sustainable. To create ZincGel Battery, they use non-flammable electrolytes andsustainable, environmentally safe components. To date, Offgrid Energy has raised more than 1.3 million dollars in fundraising.

Government Support Mechanisms for Green Startups in India

The Indian government plays a pivotal role in fostering the growth of green startups by providing a range of supportive frameworks, incentives, and policies. Key measures include grants to offset costs related to research, development, and implementation of sustainable technologies, as well as tax benefits and rate reductions to encourage eco-friendly business practices. Dedicated funding programs—such as government-backed loans, impact investment funds, and venture capital—offer targeted financial support.

The establishment of incubators and accelerators provides startups with mentorship, resources, and networking opportunities. Additionally, a transparent regulatory environment with streamlined compliance processes and clear standards for sustainability helps green businesses expand. Public procurement policies that prioritize environmentally friendly products, along with investments in scientific research and skill development initiatives, further strengthen the ecosystem. Collectively, these strategies not only drive innovation and capacity-building but also position India as a leader in sustainable entrepreneurship.

Support Type	Description/Example
Grants & Subsidies	Funding for R&D, tech adoption, and pilot
Tax Benefits	Tax holidays, reduced GST for green
Special Funding Programs	Impact on investment funds, green venture
Incubators/Accelerators	Dedicated programs for eco-startups
Regulatory Support	Streamlined compliance, clear
Public Procurement Policy	Preference for eco-friendly products in
Capacity Building	Skill development, training, and

Research Findings

The research reveals that India is rapidly creating a supportive environment for green startups, positioning the country as a future leader in sustainable innovation. Several factors contribute to this p

Positive outlook:

- Government Support and Ecosystem Development: Strategic government initiatives, combined with investor interest and ecosystem collaboration, are fostering conditions where green startups can thrive and significantly contribute to sustainable development.
- Youth Entrepreneurship: Younger generations in India are increasingly entrepreneurial, particularly in sectors aligned with sustainability and environmental values, driving the growth of innovative green startups.
- Consumer Awareness: There is a marked shift in consumer behavior, with more people adopting sustainable lifestyles and demanding eco-friendly products and services, such as renewable energy, slow fashion, vegetarianism, and sustainable transport.
- Corporate Response: Established companies are responding to changing consumer preferences by adjusting their product lines, while new green startups are emerging to meet this demand.
- Emergence of Green Unicorns: Some green startups have achieved unicorn status, highlighting their economic potential and importance within the broader business landscape.
- Sectoral Diversity: Eco-friendly startups are active across various sectors, including agriculture, food, energy, waste management, and fashion, with electric vehicle companies receiving significant funding and attention.
- Challenges: Despite the promising outlook, green startups face challenges related to access to finance, scalability, and regulatory barriers. Addressing these issues is essential for sustained growth.
- Global Alignment: The trajectory of Indian green startups mirrors global trends and aligns with the country's commitment to sustainable development.

In summary, India's green startups are poised for robust growth, driven by youth entrepreneurship, evolving consumer preferences, and supportive policies. However, overcoming financial and regulatory challenges will be crucial for these startups to realize their full potential and drive India's transition toward a sustainable future

Conclusion:

sustainable and sustainable future through young entrepreneurs. Now people start to worry and think carefully about their lifestyle and consumption habits to reduce discomfort effect. The answer is to switch to renewable energy and slow fashion, vegetarianism, sustainable transport, circular economy, etc. In response to this growing demand, established companies are beginning to adjust their product lines and new green startups are emerging. Many of these green companies are unicorns, which makes them important.

It can be summarised that eco-friendly start-ups include renewable energy, slow fashion, veganism, sustainable transport and the transition to a circular economy. In response to this growing demand, established companies are beginning to adjust their product lines and new green startups are emerging. Many of these green companies are unicorns and will become serious businesses. Environmental startups tend to favour electric vehicle companies due to

their significant funding and media exposure. This includes industries such as agriculture, food, energy, waste, and fashion. Indian electric vehicle companies Ola and Bounce were exited due to the success of ride-hailing. India is not far behind and has a lot of work to do in terms of sustainability.

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