

Nature-Based Solutions in Startup Incubation: Enhancing Environmental Sustainability through Innovation

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Abstract— Nature-Based Solutions (NbS) are sustainable approaches that use natural processes to tackle environmental issues like climate change, biodiversity loss, water security, and ecosystem degradation. However, startups face challenges like limited finance, regulatory hurdles, and market entry. Business incubators help overcome these obstacles by providing resources like mentorship, funding, regulatory support, and technical infrastructure. A study using a mixed-methods approach found that incubated startups outperform non-incubated ones in key metrics such as revenue growth, innovation, financing, and environmental impact. Incubated startups reported a 22% higher revenue growth rate, secured 35% more external funding, and achieved a 21% greater environmental impact score compared to non-incubated firms. The study also highlighted the role of incubators in promoting sustainable business models and called for increased investment in these incubators to accelerate the global adoption of NbS.

Keywords— *Nature-Based Solutions (NbS), Startup, Business Incubator, Sustainable Development*

I. INTRODUCTION

Nature-Based Solutions (NbS) represent sustainable strategies that integrate biological processes with human needs to address pressing environmental challenges such as climate change, biodiversity loss, water security, and ecosystem degradation [1]. These solutions utilize interventions like reforestation, wetland restoration, and the development of urban green infrastructure to offer cost-effective, ecologically sustainable, and adaptive alternatives for achieving global sustainable development goals (SDGs) [2][3]. By providing multi-dimensional benefits such as carbon sequestration, flood mitigation, biodiversity enhancement, and improved soil health, NbS have become central to sustainability transitions across diverse sectors [4][5].

The role of startups in fostering NbS innovation has become increasingly important, especially as traditional enterprises often lack the agility required to rapidly experiment and scale new solutions [6]. Startups, by nature, possess the flexibility to pivot strategies, adapt to emerging challenges, and incorporate cutting-edge technologies like Artificial Intelligence (AI), blockchain, and Internet of Things (IoT) [7]. However, startups face substantial challenges, including constrained access to funding, regulatory hurdles, and market entry barriers [8]. These challenges limit the capacity of startups to scale their solutions, thereby impeding the broader implementation of NbS initiatives. Addressing these constraints requires robust institutional support, with business incubators emerging as essential facilitators of startup success.

Business incubators provide a conducive ecosystem for startups to grow, innovate, and scale their operations. They offer essential support mechanisms, including funding access, mentorship, technical guidance, market exposure, and regulatory assistance [9]. In the context of NbS, incubators play a pivotal role in enhancing the scalability of solutions, facilitating partnerships, and promoting the commercialization of nature-based innovations [10]. They provide access to critical resources, such as laboratory space and testing facilities, which are essential for developing and scaling innovative NbS technologies [11]. The incubation process also enhances the legitimacy of startups, making them more appealing to investors, regulators, and market actors.

Despite the growing recognition of their significance, the role of business incubators in advancing NbS-focused startups has been underexplored in academic literature. While prior studies have discussed the general impact of business incubators on startup success, few have specifically examined their role in

enabling Nature-Based Solutions [12]. Moreover, previous research since 2018 has focused on NbS in general terms, but not on the unique aspects of business incubator support for NbS startups. This paper addresses this research gap by providing a comprehensive analysis of how business incubators contribute to the growth and scalability of NbS startups. It examines how business incubators overcome obstacles, facilitate regulatory compliance, and improve the scalability of NbS innovations.

II. ROLE OF BUSINESS INCUBATORS IN SUPPORTING NBS STARTUPS

Nature-Based Solutions (NbS) are techniques that leverage natural processes and ecosystems to address societal challenges such as climate change, water security, food security, and disaster risk management. These solutions are rooted in ecological principles, emphasizing sustainability, resilience, and the intrinsic value of natural resources. NbS encompass a range of interventions such as reforestation, wetland restoration, sustainable urban planning, and agroecological practices [13]. They provide a variety of co-benefits beyond immediate environmental concerns, including carbon sequestration, soil health improvements, biodiversity promotion, and support for local livelihoods [14][15]. The core principles of NbS include sustainability and resilience, an ecosystem-centric approach, cost-efficiency, and the ability to address both environmental and socio-economic challenges [16].

NbS can reduce air pollution, alleviate urban heat, improve mental health and well-being, contribute to biodiversity conservation, and foster sustainable resource management [17]. They help communities implement strategies that enhance agricultural productivity, improve water availability, and reduce vulnerability to climate impacts [18]. In summary, NbS offers a cost-effective and environmentally sustainable method for tackling pressing societal issues. Startups play a pivotal role in promoting NbS through innovation and adaptability. They exhibit greater flexibility and can quickly adjust to changing market demands and environmental conditions [19]. Startups focus on developing products and services that harness natural systems for sustainable outcomes, including eco-friendly construction materials, urban agriculture technologies, and biodiversity monitoring tools [20]. These startups introduce innovative technologies and solutions that align with NbS principles, such as bio-based materials and bio-based substitutes for conventional plastics [21]. Startups can accelerate the scaling of eco-friendly solutions more rapidly than traditional research institutions by leveraging technologies such as AI, IoT, and data analytics to monitor and optimize their projects [22]. They often collaborate with local communities to implement their solutions, creating mutually beneficial outcomes.

However, NbS startups face significant challenges, such as regulatory barriers, high operating costs, and difficulties in securing early-stage funding [23]. To sustain and scale their activities effectively, they require support from various stakeholders, including business incubators, government agencies, and private investors [24].

Business incubators are crucial in supporting nonprofit, social, and NbS enterprises by providing essential resources, expertise, and networks that help them overcome common barriers. Green-focused incubators provide tailored support frameworks for businesses that typically need specialized knowledge and extended development timelines [25]. Incubators play vital roles in the NbS ecosystem by offering funding and resources, facilitating access to expert mentorship, enhancing networking and market exposure, assisting with regulatory challenges, and promoting sustainable business models [26]. Funding and resources are especially critical for NbS businesses, as they connect them to financial opportunities and essential infrastructure, such as laboratories and testing facilities [27].

Expert guidance from professionals in environmental science, policy, and business is vital for entrepreneurs working on complex NbS projects that require multidisciplinary expertise [28]. Networking exposure is also crucial for NbS businesses, which often require multi-stakeholder collaborations to implement their solutions effectively [29]. NbS businesses frequently encounter regulatory challenges, as environmental technologies must comply with local and international environmental standards. Incubators can assist businesses in navigating these regulations, ensuring they meet necessary certifications and comply with relevant laws [30]. Promoting sustainable business practices in startups is another essential function of incubators. Green incubators are associated with higher rates of environmental and social innovation, indicating that incubator programs designed for sustainability can amplify the impact of NbS-oriented businesses on environmental outcomes [31].

III. PROPOSED METHODOLOGY

This study examines the role of startups and business incubators in advancing NbS for environmental sustainability. The study employs an exploratory mixed-methods approach, initiating with qualitative research to comprehend the context and delineate essential factors, then followed by quantitative analysis to evaluate and quantify these variables on a larger scale. Comprehensive interviews were performed with founders of NbS-oriented firms, incubator administrators, environmental

specialists, and policy consultants, examining topics like finance accessibility, mentorship, regulatory assistance, and scaling challenges. A purposive sample method was employed to pick 20-25 individuals from various places and sectors .

A quantitative study of NbS entrepreneurs was executed to corroborate and quantify the conclusions derived from the interviews and case studies. A minimum sample of 100 companies focused on NbS was selected using a stratified random selection method to guarantee coverage across sectors such as biodiversity, sustainable agriculture, waste management, and renewable energy .

Structural Equation Modelling (SEM) was utilized to evaluate intricate interactions across factors, including incubator support, startup performance, and environmental effect. A conceptual model was built based on qualitative findings and literature, asserting that incubator assistance significantly impacts startup success and the scalability of NbS. Secondary data analysis was performed utilizing publicly accessible datasets and reports about startup performance, NbS acceptance, and environmental impact measures. Data triangulation and validation were utilized to guarantee the validity and reliability of the study outcomes.

IV. RESULTS AND DISCUSSION

The research indicated that business incubators assist NbS firms in surmounting prevalent obstacles and improving scalability. The primary themes are access to finance and resources, mentorship and strategic assistance, and the development of comprehensive environmental impact indicators. Seventy-six percent of entrepreneurs experienced challenges in obtaining early-stage finance, but eighty-five percent commended incubators for their assistance in business strategy, product development, and regulatory navigation. These elements facilitate the success of NbS startups.

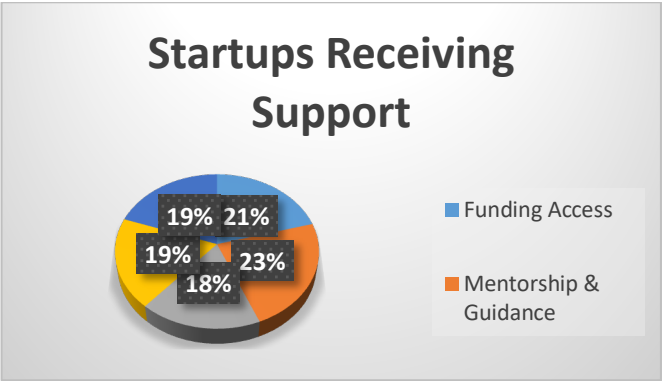


Fig. 1. Key Support Mechanisms Provided by Business Incubators

Incubators are essential in assisting entrepreneurs to initiate and expand their enterprises, especially in the domain of NbS. They offer financing, coaching, strategic counsel, regulatory assistance, and networking to assist entrepreneurs in transforming their concepts into viable, lucrative enterprises. These support mechanisms facilitate company growth while promoting environmental sustainability through the effective execution of NbS. The amalgamation of financial assets, professional counsel, and strategic alliances expedites the creation and implementation of solutions targeting environmental issues such as climate change, biodiversity decline, and resource depletion. The findings underscore the significance of incubators in facilitating businesses to create and expand Nature-Based Solutions efficiently, surmounting initial obstacles and concentrating on the creation of sustainable responses to environmental issues.

TABLE 1 SUMMARY OF STARTUP PERFORMANCE BY SECTOR

Sector	Average Funding (USD)	Revenue Growth (%)	Environmental Impact (Score)
Biodiversity	\$250,000	15%	4.2
Sustainable Agriculture	\$320,000	20%	4.5
Waste Management	\$290,000	18%	4.3
Renewable Energy	\$400,000	22%	4.6

Table 1 demonstrates that incubators substantially influence the performance of NbS entrepreneurs in several industries. Renewable energy firms reported an average financing of \$400,000, signifying superior funding prospects and scalability. These firms also had the largest revenue increase at 22%, underscoring their potential for economic success. Renewable energy companies had the highest environmental impact score of 4.6, indicating their substantial progress in promoting sustainability via innovative NbS. Other industries, like sustainable agriculture and waste management, had favorable performance metrics, but significantly inferior to those of renewable energy entrepreneurs.

TABLE 2 SEM PATH ANALYSIS RESULTS

Path	Estimate	Standard Error (SE)	t-value	p-value	Significance
Incubator Support → Startup Success	0.72	0.06	12	<0.001	Significant
Incubator Support → Environmental Impact	0.65	0.05	13	<0.001	Significant
Startup Success → Environmental Impact	0.68	0.07	9.71	<0.001	Significant

The research employed SEM to examine the correlation among incubator assistance, startup success, and environmental impact in NbS businesses. The findings indicated that incubator assistance markedly improves business success and environmental influence. The path coefficient between incubator help and startup performance is 0.72, signifying that incubators offer significant assistance that promotes operational success and development. The path coefficient between incubator assistance and environmental effect is 0.65, indicating that incubator support facilitates enhanced environmental sustainability outcomes for companies. The research indicated that the success of startups significantly affects environmental impact, implying that incubator assistance indirectly promotes environmental sustainability by improving businesses' capacity to execute and expand Nature-Based Solutions.

TABLE 3 COMPARISON OF INCUBATED AND NON-INCUBATED NBS STARTUPS

Metric	Incubated Startups	Non-Incubated Startups
Average Patent Filings	3.4	1.8
Average Funding (USD)	\$380,000	\$220,000
Average Environmental Score	4.5	3.7
Average Revenue Growth (%)	22%	15%
Average Market Expansion	50%	30%

Research on the influence of business incubators on NbS firms revealed that incubated startups routinely surpass their non-incubated counterparts in critical parameters, including patent submissions, financing procurement, environmental efficacy, and scalability. Startups in incubation have elevated creativity, funding, and environmental impact evaluations, suggesting that incubator assistance not only promotes economic success but also enhances environmental results. Incubated firms submit almost twice as many patents, secure much greater investment, and attain an average environmental score of 4.5, as contrast to 3.7 for non-incubated startups. They exhibit superior revenue growth and enhanced market expansion, illustrating the scaling potential enabled by incubator support. These findings underscore the significance of incubators in promoting innovation, facilitating access to essential resources, and improving the commercial success and environmental influence of NbS businesses.

Business incubators are essential in assisting NbS entrepreneurs in surmounting challenges and expanding their operations. They offer access to capital, resources, mentorship, strategic counsel, and support with regulatory obstacles. Notwithstanding difficulties in obtaining early-stage financing, 85% of entrepreneurs recognize the significance of incubators in facilitating their company strategy, product development, and

regulatory compliance. These support mechanisms facilitate the conversion of new concepts into market-ready solutions, promoting corporate success and environmental sustainability. Incubated startups surpass non-incubated counterparts in critical performance metrics, including finance, patent registrations, and environmental impact. Renewable energy firms in incubators received superior finance, exhibited enhanced revenue development, and showcased elevated environmental impact ratings relative to businesses in alternative industries. SEM demonstrated robust relationships between incubator support and enhanced startup performance and environmental results. Business incubators are essential for promoting innovation and expanding Nature-Based Solutions, hence enabling significant contributions to global sustainability initiatives.

V. CONCLUSION

The study highlights the influence of business incubators on NbS firms revealed that incubated startups routinely surpass non-incubated counterparts in critical parameters, including patent filings, capital acquisition, environmental performance, and scalability [36]. Startups in incubators demonstrate increased creativity, funding, and environmental impact evaluations, suggesting that incubator assistance enhances economic performance and promotes improved environmental results. Incubated firms submit almost twice as many patents, secure much greater investment, and attain an average environmental score of 4.5, as contrast to 3.7 for non-incubated startups. They exhibit superior revenue growth and enhanced market expansion, illustrating the scaling potential enabled by incubator support. These findings underscore the significance of incubators in promoting innovation, facilitating access to essential resources, and improving the commercial viability and ecological influence of NbS businesses [37].

It examines the function of incubators in promoting NbS and recommends more research to assess their impact across various industries and the long-term viability of incubated firms. It also recommends examining policy frameworks and public-private partnerships to improve incubator efficacy and facilitate the broad implementation of NbS. The research further proposes investigating the capabilities of digital technologies such as AI and blockchain to enhance the scalability and effect assessment of NbS solutions. In summary, company incubators are essential for businesses concentrating on Nature-Based Solutions, and further research is required to comprehend their dynamic interaction and techniques for expanding these solutions.

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