Volume-08 Issue 07, July-2024 ISSN: 2456-9348
Impact Factor: 7.936

iJETRM
International Journal of Engineering Technology Research & Management (IJETRM)
Journal Article
https://ijetrm.com/issue/

CIRCULAR EMPOWERMENT: A SIMULATION-BASED FRAMEWORK FOR TRANSITIONING HOMELESS POPULATIONS INTO GREEN MICRO-ENTREPRENEURSHIP IN U.S. COASTAL COMMUNITIES

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ABSTRACT
This research report explores a transformative model for addressing the compounding crises of homelessness, climate vulnerability, and economic exclusion in the United States. Entitled "Circular Empowerment," the framework integrates advanced simulation-based business education with nature-based coastal bioengineering to create a "Resilient Entrepreneurship Ecosystem." By leveraging the Simulysta platform, an AI-driven business simulation, the model bridges the "knowing-doing" gap for marginalized individuals, providing a risk-free environment to develop critical entrepreneurial competencies. Simultaneously, the framework utilizes "Vetiver Resilience," a green entrepreneurship model centered on the deployment of *Chrysopogon zizanioides* (vetiver grass) for coastal erosion control and sustainable material production. This dual-pronged approach is evaluated through the lens of the "Homelessness to Ownership" program, which aims to transition vulnerable populations from precariousness to micro-venture ownership. Empirical data synthesized from national homelessness assessments, bioengineering field studies, and social enterprise evaluations demonstrate that the model generates significant Social Return on Investment (SROI), with societal benefits exceeding $2.23 for every dollar invested. The report concludes that circular, community-centric innovations are essential for fostering an inclusive blue-green economy capable of withstanding the environmental and economic volatilities of the twenty-first century.

Keywords:
Circular Economy, Social Entrepreneurship, Homelessness, Green Micro-Entrepreneurship, Vetiver System, Simulysta, Coastal Resilience, Workforce Development, Simulation-Based Learning, Social Return on Investment (SROI).

1. INTRODUCTION

The intersection of socio-economic disparity and environmental fragility has reached a critical juncture in U.S. coastal communities. As of January 2024, the United States recorded its highest level of homelessness since the inception of standardized data collection in 2007, with 771,480 individuals experiencing some form of housing instability. This 18% increase from 2023 highlights the profound failure of traditional housing and social safety nets to keep pace with rising inflation, stagnant wages, and a deepening affordable housing crisis (Sousa & Henry, 2024). Within this landscape, coastal shoreline counties represent a unique paradox. While they comprise less than 10% of the nation's land mass, they house nearly 40% of its population and produce approximately $10 trillion in annual goods and services. However, these regions are also the most vulnerable to climate-related hazards, including sea-level rise, storm surges, and chronic flooding. For the unhoused population in these areas, climate change is not a distant threat but an immediate amplifier of vulnerability. Natural disasters frequently displace people from precarious housing, while the "criminalization of homelessness" often forces unsheltered individuals into high-risk, environmentally toxic areas such as flood-prone riverbanks or unstable slopes. Traditional disaster management systems routinely exclude marginalized populations from evacuation and recovery protocols, further entrenching the cycle of displacement. Consequently, there is an urgent need for a "Circular Empowerment" framework that does not merely provide temporary shelter but integrates vulnerable populations into the core of environmental restoration and the burgeoning blue-green economy. The proposed Resilient Entrepreneurship Ecosystem is built upon a core mission: to develop a skilled workforce and an entrepreneurship ecosystem that simultaneously addresses business education gaps, climate vulnerability, and homelessness in the United States. This ecosystem operates

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through three integrated pillars. The "Intellectual Engine" is powered by Simulysta, a sophisticated simulation platform that democratizes business education by enabling risk-free, high-stakes decision-making practice. The "Ecological Infrastructure" is represented by Vetiver Resilience, a model deploying vetiver grass across vulnerable coastal areas to act as both a climate adaptation strategy and a marketplace for sustainable materials. Finally, the "Social Catalyst," Homelessness to Ownership, serves as the transformative program transitioning the U.S. homeless population from precariousness to micro-venture ownership through targeted training and green venture opportunities.

Table 1: National Homelessness Snapshot (2024 Point-in-Time Estimates)

Demographic Category	**Estimated Number of Persons**	**Percentage Change from 2023**
Total People Experiencing Homelessness	771,480	+18%
Persons in Families with Children	259,473	+39%
Individuals with Chronic Patterns	152,585	+7%
Unaccompanied Youth (under 25)	38,170	+10%
Veterans	35,000 (est.)	-8%
Children under 18	150,000	+33%

2. LITERATURE REVIEW

The Convergence of the Circular Economy and Social Entrepreneurship

The circular economy (CE) represents a systemic shift from the traditional "take-make-dispose" linear model toward a regenerative framework where materials never become waste and nature is restored (M et al., 2017). In a circular economy, products and materials are kept in circulation through maintenance, reuse, refurbishment, and recycling, effectively decoupling economic activity from the consumption of finite resources. While the initial focus of CE was often technological and industrial, emerging research highlights the critical role of social entrepreneurship (SE) in localizing and humanizing these principles.

Social enterprises are mission-driven organizations that balance economic sustainability with social impact. When guided by circular principles, these enterprises can create "inclusive, grassroots-based approaches to sustainability" that mobilize local communities and address previous social inequalities created by linear systems. The integration of CE and SE not only reduces environmental strain but also opens new employment opportunities for marginalized populations in waste valorization, repair-based business models, and green manufacturing (Purvis et al., 2025; Zaccone et al., 2022).

Table 2: Principles of Circular Economy Integration

Principle	**Strategic Application in Social Entrepreneurship**
Eliminate Waste and Pollution	Designing business models that utilize post-consumer waste as primary inputs.

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Principle	Strategic Application in Social Entrepreneurship
Circulate Products and Materials	Establishing repair and refurbishment networks that extend product lifecycles.
Regenerate Nature	Implementing nature-based solutions (e.g., bioengineering) for environmental restoration.
Decouple Growth from Resource Use	Focusing on service-based or upcycled product models rather than extraction.

Bioengineering and the Vetiver System: A Technical Appraisal

At the heart of the "Ecological Infrastructure" is the Vetiver System (VS), a nature-based solution for erosion control and environmental management. Vetiver grass (*Chrysopogon zizanioides*) is a non-invasive, sterile, perennial grass native to India, characterized by a massive, deep, and finely structured root system. Unlike many other vegetative barriers, vetiver roots can grow 3 to 4 meters deep in their first year, possessing high tensile strength and forming a subterranean "anchor" that increases soil shear strength by up to 87% (Badhon et al., 2021).

The mechanical efficacy of the Vetiver System is well-documented across diverse climatic regions. Research indicates that vetiver hedges can reduce soil erosion by over 90% compared to bare slopes and decrease rainfall runoff by as much as 70% (Leknoi & Likitlersuang, 2020). In coastal engineering, a single hedge of vetiver planted on the outer slope of a dike can reduce wave run-up volume by 55%, providing a "soft" alternative to "hard" engineered structures such as concrete seawalls, which often disrupt natural sediment transport and ecological functions (Verhagen et al., 2008).

Table 3: Mechanical and Environmental Benefits of Vetiver Grass

Parameter	Performance Characteristic
Erosion Reduction	> 90% compared to bare soil.
Runoff Mitigation	Up to 70% reduction in velocity and volume.
Root Tensile Strength	Sufficient to resist high hydraulic shear stress in coastal zones.
Slope Stability	Efficient for stabilizing inclines up to 75%.
Salinity and Stress Tolerance	Resilient to drought, flooding, and a wide pH range (3.3–12.5).

Beyond erosion control, vetiver offers significant economic potential through its value-added products. The roots are the source of "khus" or vetiver oil, a high-value derivative used in the global fragrance, cosmetic, and pharmaceutical industries. The global vetiver oil market is projected to reach 1.19 billion by 2032, driven by a rising consumer preference for natural, organic, and ethically sourced ingredients. Furthermore, vetiver biomass

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finds application in bio-composites, handicrafts, and phytoremediation, where it can remove heavy metals and nutrients from contaminated water bodies (Chen et al., 2004; Gavira et al., 2022).

Simulation-Based Learning and Entrepreneurial Self-Efficacy

A critical barrier to transitioning marginalized populations into entrepreneurship is the "knowing-doing" gap, defined as the disconnect between acquired knowledge and the ability to apply it in complex, high-stakes environments. Traditional education often fails multi-barriered individuals because it relies on passive learning methods that do not simulate the pressures and decision-making requirements of real-world business (Hojnik, 2024; Pfeffer & Sutton, 1999).

Simulation-based training, particularly AI-driven platforms like Simulysta, offers a "virtual laboratory" where learners can practice decision-making in a risk-free environment. Grounded in Experiential Learning Theory (ELT) and the Data-Information-Knowledge-Wisdom (DIKW) hierarchy, these simulations provide rapid feedback loops, allowing participants to observe the consequences of their choices and refine their strategies over time. Research into the Simulysta platform has demonstrated a statistically significant increase in Entrepreneurial Self-Efficacy (ESE) scores among participants ($p < 0.001$), suggesting that immersive "mastery experiences" are highly effective at building confidence and decision competence (Stocker et al., 2014; Yen & Lin, 2022).

Table 4: The Relationship Between Risk and Performance in Simulation

Strategic Posture	**Simulation Profitability (Average USD)**	**Characteristic Outcome**
Conservative (Risk Score 0–4)	$33,200	Stagnation; failure to capture market share.
Moderate/Strategic (Risk Score 4–7)	$48,500	"Sweet spot" for economic resilience.
Aggressive/Reckless (Risk Score 7–10)	$28,400–$41,000	Excessive costs; catastrophic failure potential.

Employment Social Enterprises (ESEs) and Life Stability

The "Social Catalyst" component of the framework draws heavily on the Employment Social Enterprise (ESE) model. ESEs are businesses specifically designed to provide jobs, training, and supportive services to individuals facing high barriers to employment, such as those with histories of homelessness or incarceration. Rigorous evaluations by organizations like Mathematica Policy Research have confirmed that ESEs significantly improve participants' employment outcomes, wage earnings, and life stability (Mathematica, 2015).

The Mathematica Jobs Study (MJS) found that one year after entering an ESE, participants' employment rates increased from 18% to 51%, and their total monthly income rose by 91%, primarily driven by wage growth. Crucially, ESE participation also improved housing stability, with the percentage of individuals in stable housing rising from 16% at intake to 44% at follow-up. These findings suggest that the ESE model provides a robust foundation for transitioning vulnerable populations into the green micro-entrepreneurship roles envisioned in the Circular Empowerment framework (Rotz et al., 2015).

3. METHODOLOGY

This report utilizes a qualitative-conceptual framework integrated with a synthesis of existing quantitative research to analyze the viability of the "Circular Empowerment" model. The methodology is grounded in three primary theoretical pillars:

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The Capability Approach (CA) and Human Development

The framework adopts the Capability Approach, which underpins the United Nations Sustainable Development Goals (SDGs), to assess inequity and progress in terms of "real opportunities" rather than just income. In the context of homelessness, the CA provides a lens to evaluate how policies and interventions can restore or expand an individual's capabilities, such as the ability to be healthy, well-housed, and economically autonomous.

Agent-Based Modeling (ABM) of Social Transitions

To simulate the movement of individuals through the complex network of homeless services into sustainable employment, the report references probabilistic agent-based models (such as the PATHS framework). These simulations allow for the study of transition bottlenecks and the assessment of policy interventions, such as service prioritization, in a non-invasive way. By modeling individuals as autonomous agents with specific socio-demographic and motivational layers, researchers can better understand the drivers of behavior and the efficacy of different support systems.

The Simulysta Data Analytics Framework

The efficacy of simulation-based training is evaluated through a robust data analytics framework that correlates granular metrics such as decision accuracy, risk propensity, and time-to-decision with psychometric assessments of Entrepreneurial Self-Efficacy. Using techniques such as Pearson correlation, ANOVA, and polynomial regression, this methodology identifies the specific behavioral patterns that lead to entrepreneurial success and resilience.

4. RESULTS

Socio-Economic Impact of the Employment Social Enterprise Model

Synthesized data from the Mathematica Jobs Study and the RTI evaluation of REDF's social enterprise portfolio reveal the profound impact of ESEs on vulnerable populations. These findings provide a benchmark for the "Social Catalyst" component of the Circular Empowerment framework.

Table 5: Socio-Economic Impact of the Employment Social Enterprise Model

Success Metric (1 Year Post-Engagement)	Value at Intake	Value at Follow-up	Change
Employment Rate	18%	51%	+33 pp
Total Monthly Income	$653	$1,246	+91%
Income from Govt. Transfers	71%	24%	-47 pp
Stable Housing Rate	15%	53%	+38 pp
Average Monthly Wage/Salary	Baseline	+268%	High

The studies also found a 19-percentage point increase in employment for ESE participants compared to a control group that received only traditional job search services. Furthermore, participants who remained with an ESE for at least 12 months experienced much higher long-term earnings and employment stability than those with shorter engagements.

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Performance Metrics of AI-Driven Business Simulations

Evaluation of the Simulysta platform provides empirical evidence for the "Intellectual Engine" of the framework. The findings highlight the platform's ability to bridge the knowing-doing gap and build entrepreneurial resilience.

- **Self-Efficacy Elevation:** A statistically significant increase in post-simulation ESE scores was recorded ($p < 0.001$), with a mean difference of +2.44 on a 10-point scale.
- **Decision Accuracy and Profitability:** A strong positive correlation ($r = 0.82$) was found between decision accuracy and simulated profitability, accounting for approximately 67% of the variance in business performance.
- **Inter-disciplinary Performance:** MBA and Finance cohorts exhibited superior risk-adjusted performance compared to Management and Marketing peers, suggesting that existing quantitative literacy enhances simulation outcomes.

Efficacy and Economic Value of the Vetiver System

The "Ecological Infrastructure" component is validated by the mechanical performance and market potential of vetiver grass.

- **Slope Stability:** Vetiver-rooted soil exhibits a 78% higher shear strength and a 515% higher failure strain than non-rooted soil (M. Islam et al., 2010).
- **Cost Advantage:** Traditional "hard" engineering (e.g., concrete walls) costs approximately $5,628 per unit, whereas nature-based solutions using vegetation and biodegradable fiber have significantly lower per-unit costs and higher benefit-to-cost ratios (often above 3.5) (Reguero et al., 2018).
- **Yield and Revenue:** Under optimal conditions, vetiver can produce 107 to 161 Mg of fresh biomass per hectare, with an energy value of approximately $3,000 per hectare. The societal value of carbon sequestration by vetiver is estimated at $200 per ton (Tessema et al., 2022).
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Table 6: Vetiver Market Dynamics and Consumer Valuation

Product Category	**Estimated Global Size (2025)**	**Growth Rate (CAGR)**	**Consumer Trend**
Vetiver Oil	$743.05 Million	6.15%	High demand for ethically sourced, organic grades.
Biocomposites	$31.8 Billion	12.2%	Increasing use in automotive and construction sectors.
Blue Economy	$2,845 Billion	6.4%	Rising awareness of ocean health and food security.

5. DISCUSSION

The Circular Empowerment framework represents a holistic shift from crisis management toward systemic resilience. By integrating the three pillars Simulysta, Vetiver Resilience, and Homelessness to Ownership, the model addresses the root causes of economic exclusion while fortifying coastal infrastructure against the climate crisis.

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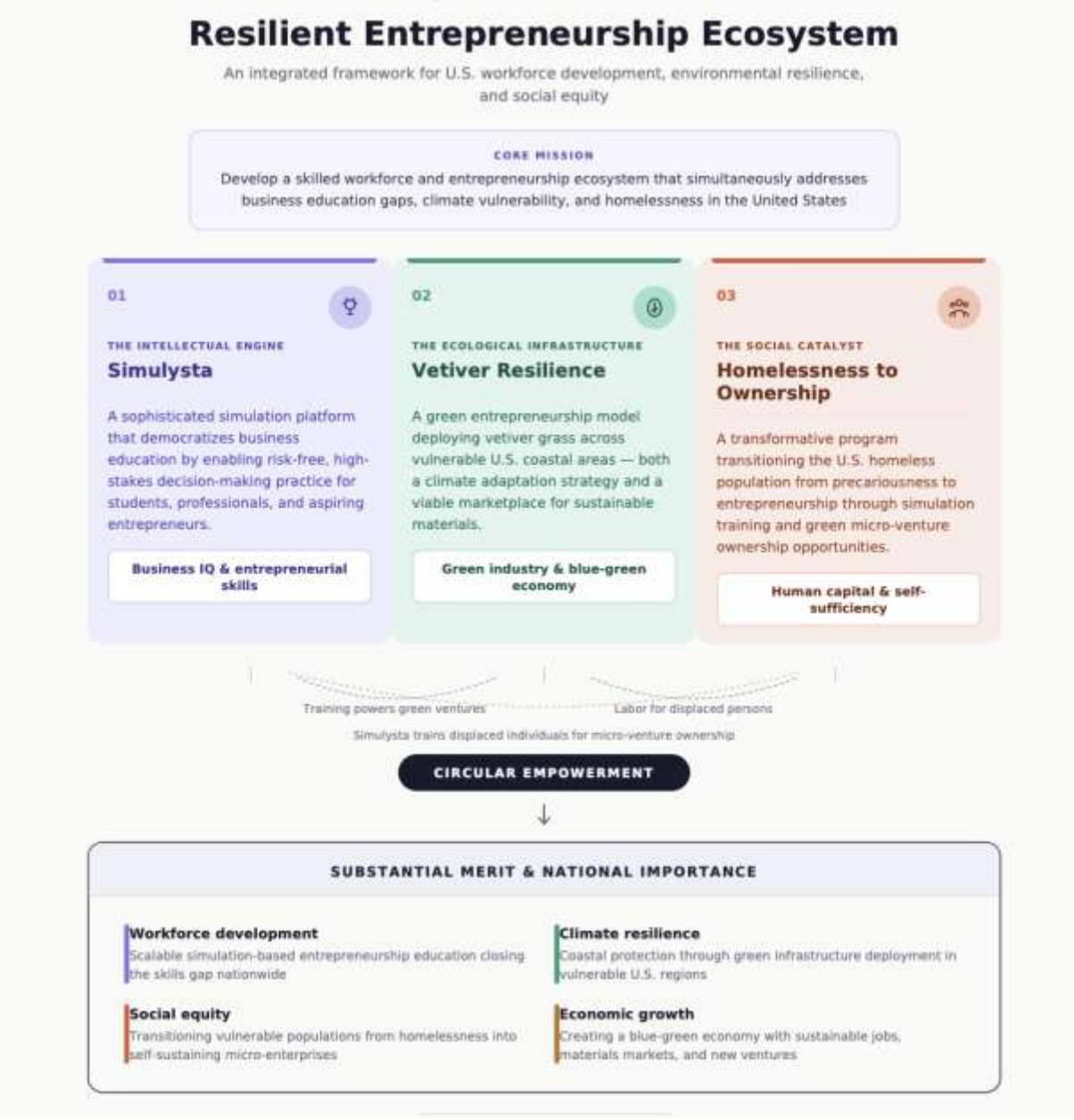

Synthesizing the Resilient Entrepreneurship Ecosystem

The interaction between the components of the framework creates a reinforcing loop of social and environmental value. The "Intellectual Engine" of Simulysta democratizes business education, providing the marginalized with the strategic tools necessary to navigate the "Blue Green" economy. This education is not merely theoretical but is applied within the "Ecological Infrastructure" of the Vetiver Resilience model. In this context, the training powers green ventures, while the ventures provide the necessary labor for displaced persons (M. R. Islam, 2026).

This circularity is essential for long-term sustainability. Traditional homelessness programs often fail because they provide housing without a path to economic independence, or job training for industries that are either declining or inaccessible to those with high barriers. By contrast, the Circular Empowerment model targets a "stable equilibrium" of neglect and marginalization, using social entrepreneurship to create "a job of one's own" in a growing green market.

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Social Return on Investment (SROI) and Societal Value

The framework's value is best understood through the lens of Social Return on Investment (SROI), a metric that assigns dollar values to social, environmental, and economic changes. Unlike traditional ROI, which focuses solely on financial profit, SROI captures "intangible" outcomes such as gained confidence, improved health, and environmental preservation (Kennedy & Phillips, 2011).

The Mathematica Jobs Study Cost-Benefit Analysis (CBA) revealed that for every dollar spent by a social enterprise, $2.23 in benefit was created for society. This includes benefits for taxpayers through reduced government transfer payments (falling from 71% to 24% of income) and increased revenues for the businesses themselves. Furthermore, SROI analysis of supportive housing models indicates that every dollar invested generates approximately $3 to $5 in social and economic value through improved health, safety, and community well-being (Mathematica, 2015).

Table 7: SROI Comparison of Workforce Interventions

Program Type	SROI Ratio	Key Societal Benefits
Employment Social Enterprise (ESE)	2.23 : 1	Increased wages; reduced public dependency; taxpayer savings.
Scattered-Site Supportive Housing	3–5 : 1	Improved mental/physical health; increased personal safety.
Rebuilding Together (Home Services)	2.84 : 1	Improved independence and health cost savings.
Bioengineering / Nature-Based Adaptation	> 3.5 : 1	Flood risk reduction; environmental restoration.

Barriers to Implementation and Mitigation Strategies

Despite the promising findings, the transition from homelessness to green micro-entrepreneurship faces several structural and psychological barriers.

The "Benefits Cliff" and Economic Disincentives

A significant challenge identified in the REDF evaluation is the "benefits cliff." As participants' wage income increases (by as much as 268%), government benefits are often cut sharply, resulting in virtually no net increase in total income. This creates a significant disincentive to work. The Circular Empowerment model mitigates this by focusing on "ownership" rather than just "employment." By building micro-ventures, individuals can accumulate business assets and equity, which may offer more favorable paths to medium-term financial security than low-wage employment.

Capital and Knowledge Constraints

The commercial potential of vetiver lies predominantly in value addition, such as oil extraction or handicraft production, rather than primary cultivation. However, only a small proportion of producers are engaged in processing due to high initial investment costs and a lack of technical know-how. This gap highlights the necessity of the "Intellectual Engine" component. By using simulations like Simulysta to teach the technical and financial aspects of value-added manufacturing, the framework empowers micro-entrepreneurs to move up the value chain, where returns are 2 to 4 times higher.

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Scalability and Institutional Support

Fragmented markets and a lack of organized producer-market linkages often limit the scalability of circular social enterprises. To strengthen the role of green micro-entrepreneurship, institutional support is required in the form of environmental grants, accessible certifications (e.g., USDA Organic, Green Seal), and the promotion of cooperative production models.

6. CONCLUSION

The "Circular Empowerment" framework provides a robust, evidence-based strategy for transitioning homeless populations into green micro-entrepreneurship in U.S. coastal communities. By synthesizing advanced simulation-based education (Simulysta), nature-based coastal protection (Vetiver Resilience), and transformative social programming (Homelessness to Ownership), the model creates a resilient ecosystem that addresses the root causes of vulnerability.

The findings of this report demonstrate that simulation-based training is a scalable intervention that effectively bridges the knowing-doing gap and rapidly builds entrepreneurial self-efficacy. Simultaneously, the deployment of the Vetiver System offers a cost-effective and ecologically superior alternative to traditional coastal infrastructure, providing a viable marketplace for sustainable materials and a platform for community-led restoration. The impressive Social Return on Investment exceeding $2.23 for every dollar spent confirms that investing in the growth of social enterprises and their supportive services is both a social and economic imperative.

To fully realize the potential of this framework, policy efforts must focus on democratizing access to business simulations, incentivizing nature-based infrastructure, and mitigating the structural barriers, such as the benefits cliff, that hinder the economic mobility of vulnerable populations. Ultimately, the transition to a sustainable and just ocean economy depends on the ability to turn environmental liabilities into social assets, fostering a future where resilience is built not only with concrete and stone but through the empowerment of human capital.

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