

DECISION-ORIENTED FORESIGHT FOR TRANSFORMING ENTREPRENEURIAL ECOSYSTEMS TOWARD 2040

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ABSTRACT

Objective: This study aims to identify and operationalize the most strategic future scenario for transforming Ecuador's entrepreneurial ecosystem toward 2040, addressing the gap between high entrepreneurial activity and limited structural transformation through a decision-oriented foresight approach.

Originality/Value: The article advances strategic foresight by shifting the focus from scenario construction to scenario selection and commitment. It introduces a transparent and replicable framework that integrates participatory criteria definition and multi-criteria decision analysis to legitimize strategic choice in fragmented and uncertain contexts.

Methods: A multi-method design was applied. Causal Layered Analysis was used to construct four alternative future scenarios. A high-competence expert panel was selected using the K coefficient method. Strategic evaluation criteria were prioritized through the Régnier Abacus, and scenarios were ranked using the Analytic Hierarchy Process. The selected scenario was operationalized through strategic roadmapping with backcasting to 2040.

Results: The results identify a science- and technology-based entrepreneurial ecosystem as the most strategic scenario, achieving the highest global priority by balancing relevance, feasibility, desirability, and transformative capacity. Relevance and feasibility were weighted more strongly than radical disruption.

Conclusions: The study shows that ecosystem transformation requires structured mechanisms for collective strategic choice. The proposed framework enhances foresight's decision value by linking participatory evaluation, consistency, and actionable long-term planning.

Keywords: Strategic Foresight. Entrepreneurial Ecosystems. Decision-oriented Foresight. Innovation Governance. Strategic Roadmapping.

FUTURE STUDIES RESEARCH JOURNAL
Scientific Editor: Renata Giovino Spers
Evaluation: Double Blind Review, pelo SEER/OJS
Received: 05/02/2026
Accepted: 30/07/2026

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ROSPECTIVA ORIENTADA À DECISÃO PARA TRANSFORMAR ECOSISTEMAS EMPREENDEDORES ATÉ 2040

RESUMO

Objetivo: Este estudo tem como objetivo identificar e operacionalizar o cenário futuro mais estratégico para a transformação do ecossistema empreendedor equatoriano até 2040, enfrentando o descompasso entre elevada atividade empreendedora e baixa transformação estrutural por meio de uma abordagem de prospectiva orientada à decisão.

Originalidade/Valor: O artigo desloca o foco da construção de cenários para sua seleção e comprometimento estratégico. Propõe um arcabouço transparente e replicável que integra a definição participativa de critérios e a análise multicritério para legitimar escolhas estratégicas em contextos fragmentados e incertos.

Métodos: Foi adotado um desenho multimétodo. A Análise Causal em Camadas foi utilizada para construir quatro cenários futuros alternativos. Um painel de especialistas de alta competência foi selecionado por meio do coeficiente K. Os critérios estratégicos foram priorizados com o Ábaco de Régnier e os cenários hierarquizados pelo Processo Analítico Hierárquico. O cenário selecionado foi operacionalizado por meio de roadmapping estratégico com backcasting até 2040.

Resultados: Os resultados indicam que um ecossistema empreendedor baseado em ciência e tecnologia constitui o cenário mais estratégico, ao equilibrar relevância, viabilidade, desejabilidade e capacidade transformadora, com ênfase na coerência estrutural e institucional.

Conclusões: O estudo demonstra que a transformação do ecossistema exige mecanismos estruturados de escolha estratégica coletiva. O framework proposto amplia o valor decisório da prospectiva ao articular avaliação participativa, consistência metodológica e planejamento estratégico de longo prazo.

Palavras-chave: Prospectiva Estratégica. Ecossistemas Empreendedores. Prospectiva Orientada à Decisão. Governança da Inovação. Roadmapping Estratégico.

1. INTRODUCTION

Entrepreneurial ecosystems have become a central framework for understanding how countries promote innovation, competitiveness, and sustainable economic development. Rather than depending solely on the creation of new firms, ecosystem performance emerges from the interaction among entrepreneurs, universities, industry, government, financial institutions, and supporting organizations that collectively shape entrepreneurial activity and innovation outcomes (Acs et al., 2017). In emerging economies, however, these interactions are frequently constrained by institutional fragmentation, weak innovation capabilities, and structural barriers that prevent entrepreneurial activity from generating sustained

technological and economic transformation (Stam, 2015). Consequently, one of the greatest contemporary challenges is no longer simply stimulating entrepreneurial activity, but guiding entrepreneurial ecosystems toward long-term development trajectories capable of producing systemic innovation and sustainable competitiveness.

Ecuador illustrates this challenge particularly well. Although the country reported one of the highest Total Early-Stage Entrepreneurial Activity (TEA) rates in Latin America, reaching 32.7% in 2023 (GEM, 2023), entrepreneurial activity continues to be driven predominantly by necessity rather than opportunity (ESPAE, 2024). Evidence indicates that the prevalence of high-growth firms is strongly associated with the overall quality and interdependence of entrepreneurial ecosystem elements (Stam & van de Ven, 2021). Likewise, research conducted in Ecuador suggests that the country's entrepreneurial activity has not yet translated into proportional improvements in innovation capacity or quality of life, reflecting persistent structural weaknesses within the national ecosystem (Aguirre et al., 2021). Although the number of registered enterprises has increased substantially in recent years, this quantitative expansion has not been accompanied by an equivalent strengthening of innovation performance, indicating that entrepreneurial growth alone is insufficient to transform the ecosystem (INEC, 2022).

These structural limitations extend beyond entrepreneurial activity itself. Recent foresight research identifies insufficient research and development capacity, collaboration culture, and public governance among the strategic conditions shaping the ecosystem's long-term evolution (Hernández & Bas, 2026). At the same time, high levels of business informality, restricted access to entrepreneurial finance, and limited innovation support mechanisms reduce the capacity of the ecosystem to generate science- and technology-based ventures (AEI, 2022). Moreover, empirical evidence indicates that entrepreneurial success in Ecuador depends on the combined interaction of institutional, educational, financial, and innovation-related conditions rather than on individual entrepreneurial capabilities alone (Ayaviri-Nina et al., 2023). These findings reinforce the notion that ecosystem transformation requires coordinated interventions addressing multiple systemic dimensions simultaneously.

Such complexity demonstrates that entrepreneurial ecosystems cannot be transformed through conventional planning approaches based exclusively on economic incentives or isolated policy interventions. Instead, they evolve as complex adaptive systems in which institutional, social, economic, technological, and cultural dimensions interact dynamically, producing nonlinear patterns of change that challenge traditional forecasting approaches (Amer et al., 2013). Recognizing these challenges, the Government of Ecuador has promoted

long-term initiatives aimed at strengthening entrepreneurship, innovation, and sustainability through the *Estrategia Ecuador Emprendedor, Innovador y Sostenible 2030* (Presidency of the Republic of Ecuador, 2021). Nevertheless, defining strategic priorities capable of coordinating ecosystem actors under conditions of uncertainty remains a significant challenge. Consequently, understanding how alternative development pathways emerge and how collective actors can intentionally shape them has become a central concern within Strategic Foresight.

Strategic Foresight has substantially advanced the exploration of uncertainty through the development of alternative future scenarios, enabling governments and organizations to anticipate change, improve strategic learning, and strengthen long-term decision-making (Rohrbeck & Kum, 2018). However, the literature has concentrated primarily on constructing plausible futures, whereas comparatively less attention has been devoted to establishing transparent procedures for evaluating competing scenarios, selecting a preferred future, and translating that choice into coordinated strategic action. As a result, many foresight exercises conclude with a portfolio of alternative futures without providing an explicit and reproducible mechanism for determining which scenario should guide long-term decision-making (Hines et al., 2024).

To address this methodological gap, this study proposes a decision-oriented foresight framework that integrates qualitative scenario development with structured multi-criteria decision analysis. Four alternative futures for Ecuador's entrepreneurial ecosystem were developed using Causal Layered Analysis (CLA). Subsequently, strategic evaluation criteria were identified through the Régnier Abacus and prioritized using the Analytic Hierarchy Process (AHP). Finally, the preferred scenario was operationalized through Strategic Roadmapping supported by a backcasting approach, thereby connecting long-term anticipation with implementation-oriented planning (Phaal et al., 2004).

Accordingly, the objective of this study is to identify and operationalize the most strategic future scenario for transforming Ecuador's entrepreneurial ecosystem toward 2040 through an integrated decision-oriented foresight approach. Beyond its empirical contribution, the study advances the Strategic Foresight literature by proposing a transparent methodological framework that explicitly distinguishes three complementary stages of foresight practice: scenario construction, scenario evaluation, and scenario implementation. By integrating participatory criteria definition, multi-criteria decision analysis, and strategic roadmapping within a single analytical architecture, the proposed framework strengthens the decision-support capacity of foresight and provides a replicable methodological approach for

guiding long-term entrepreneurial ecosystem transformation under conditions of uncertainty and institutional complexity.

2. THEORETICAL FRAMEWORK

2.1. Entrepreneurial Ecosystems as Complex Adaptive Systems

Entrepreneurial ecosystems have progressively evolved from being viewed as collections of independent entrepreneurial actors to being understood as complex adaptive systems (Stam, 2015). This perspective recognizes that entrepreneurial outcomes emerge not only from the capabilities of individual entrepreneurs but also from the dynamic interactions among universities, firms, governments, financial institutions, support organizations, and civil society. Rather than operating in isolation, these actors collectively shape the conditions under which knowledge is created, resources are mobilized, and innovation flourishes, making ecosystem performance an inherently systemic phenomenon.

Viewing entrepreneurial ecosystems through a complexity lens has fundamentally transformed the study of entrepreneurship. As Autio et al. (2018) argue, ecosystem evolution follows nonlinear trajectories characterized by feedback loops, adaptation, and path dependence rather than predictable sequences of development. Consequently, changes affecting one component of the ecosystem often generate cascading effects throughout the broader institutional environment. This perspective suggests that entrepreneurial development cannot be explained through isolated variables but instead requires understanding the interdependencies that continuously reshape the system.

From this standpoint, the strength of an entrepreneurial ecosystem depends less on the existence of individual organizations than on the quality of the relationships established among them. Acs et al. (2017) emphasize that institutions, finance, knowledge infrastructures, public policies, and entrepreneurial culture operate as complementary elements whose interactions determine the ecosystem's capacity to generate innovation and competitiveness. Similarly, Bosma et al. (2020) argue that entrepreneurial ecosystems achieve stronger performance when entrepreneurial activity is supported by favorable institutional conditions, knowledge infrastructures, and coordinated support mechanisms. The strategic value of these components therefore lies not only in their individual contribution but also in their ability to reinforce one another through coordinated action.

This relational perspective also explains why ecosystems exhibiting similar levels of entrepreneurial activity frequently produce markedly different development outcomes.

According to Spigel and Harrison (2018), entrepreneurial dynamism alone is insufficient to generate innovation-led growth when new ventures remain weakly connected to research institutions, sources of finance, and collaborative knowledge networks. In mature ecosystems, competitive advantage arises from the density and quality of these interactions rather than from the simple number of firms created, highlighting that ecosystem effectiveness is ultimately a function of systemic connectivity.

The complexity of these interactions becomes even more evident in emerging economies, where entrepreneurial activity develops under conditions of institutional instability, fragmented governance, and unequal access to strategic resources. Such environments often foster necessity-driven entrepreneurship while limiting pathways toward innovation-oriented and productivity-enhancing ventures (Amorós & Bosma, 2014). Consequently, ecosystem transformation depends not only on stimulating entrepreneurial activity but also on strengthening the institutional arrangements capable of supporting knowledge creation, collaboration, and long-term learning.

Ecuador reflects many of these structural characteristics. Although the country consistently reports one of the highest levels of entrepreneurial activity in Latin America (GEM, 2023), much of this activity remains disconnected from science, technology, and innovation systems. Collaboration culture and public governance have been identified as strategic drivers of the ecosystem's long-term evolution (Hernández & Bas, 2026), while structural barriers affecting finance and institutional coordination reduce its capacity to support high-value entrepreneurial ventures. These conditions illustrate that entrepreneurial intensity alone does not necessarily translate into structural transformation.

Understanding entrepreneurial ecosystems as complex adaptive systems therefore provides an appropriate conceptual foundation for examining how long-term transformation can be intentionally guided. As Stam and van de Ven (2021) contend, sustainable ecosystem evolution requires coordinated institutional change rather than isolated interventions targeting individual actors or organizations. This systemic perspective naturally connects with Strategic Foresight, whose purpose extends beyond anticipating possible futures to supporting collective decisions capable of reshaping complex systems over time.

2.2. Strategic Foresight and Scenario Development

Strategic Foresight has evolved from a predominantly exploratory exercise into a strategic capability that enables organizations and governments to anticipate change, navigate uncertainty, and support long-term decision-making. Rather than attempting to predict a single

future, foresight encourages the systematic exploration of multiple plausible futures, recognizing that uncertainty is an inherent characteristic of complex socio-economic systems. As noted by Amer et al. (2013), scenario planning has become one of the most widely adopted approaches within Strategic Foresight because it enables decision-makers to examine alternative trajectories while reducing dependence on deterministic forecasting.

Rather than constituting a single methodology, Strategic Foresight encompasses a broad family of future-oriented practices that contribute to organizational learning, strategic adaptation, and long-term governance. Fergnani (2022) argues that these practices strengthen organizations' ability to question dominant assumptions, reinterpret environmental signals, and improve strategic learning under conditions of uncertainty. Consequently, foresight has progressively evolved from an analytical exercise into an organizational capability that supports continuous adaptation rather than episodic planning.

The growing importance of Strategic Foresight is closely associated with the increasing volatility, uncertainty, complexity, and ambiguity characterizing contemporary policy environments. In response, governments and international organizations have progressively institutionalized foresight as a governance capability for strengthening resilience and improving long-term public decision-making. The European Commission (2021) identifies Strategic Foresight as an essential instrument for anticipating systemic transformations and reinforcing policy coherence, while the OECD (2021) emphasizes its relevance for designing science, technology, and innovation policies capable of responding to structural societal challenges beyond conventional planning horizons.

This increasing institutional relevance has also stimulated the expansion of foresight into new organizational and technological contexts. Savolainen and Knudsen (2025) argue that combining Strategic Foresight with decision approaches designed for uncertainty can enhance strategic flexibility as technological, economic, and institutional conditions evolve. Likewise, recent advances in artificial intelligence are beginning to complement traditional foresight methods by improving the identification and interpretation of emerging patterns of change, thereby expanding the analytical capabilities available to decision-makers without replacing expert judgement (Barbosa et al., 2024).

Within this broader context, scenario development has become one of the principal methodological instruments of Strategic Foresight. Rather than describing probable futures, scenarios provide coherent narratives that allow decision-makers to examine how different combinations of driving forces, uncertainties, and strategic choices may shape alternative development pathways. According to Meissner (2013), scenarios create value because they

improve strategic conversations, facilitate collective reflection, and enable organizations to evaluate the implications of different courses of action before committing resources to a particular strategy.

More recent contributions further emphasize that scenarios should not be interpreted as predictions but as analytical devices that stimulate strategic thinking. Hines et al. (2024) proposes that archetype scenarios help decision-makers recognize recurring patterns of change across different contexts, thereby improving the interpretation of uncertainty and broadening the range of strategic responses. Recent literature also suggests that, despite the growing maturity of Strategic Foresight, organizations continue to face significant challenges when attempting to translate scenario exercises into operational decisions and sustained implementation processes, particularly within small and medium-sized enterprises (Dörr et al., 2024). This observation reinforces the need for methodological approaches capable of connecting exploratory foresight with actionable decision support.

Beyond supporting anticipation, Strategic Foresight also seeks to challenge dominant assumptions about the future and stimulate transformative thinking. Inayatullah (2008) argues that meaningful long-term change requires moving beyond surface-level trends to question the deeper structures, worldviews, and narratives that shape collective expectations. From this perspective, the purpose of scenario development extends beyond describing alternative futures; it becomes a process through which competing visions of the future are explored, debated, and critically examined before strategic decisions are made.

Taken together, these perspectives demonstrate that Strategic Foresight provides a robust conceptual foundation for exploring alternative futures in complex systems characterized by uncertainty and institutional change. However, the literature has devoted considerably greater attention to the construction of scenarios than to the systematic selection of the future that should guide collective action. This distinction becomes particularly relevant when multiple plausible futures coexist and strategic actors must determine which one deserves institutional commitment and long-term implementation. Addressing this challenge requires extending the role of foresight beyond scenario generation toward transparent and participatory decision processes, an issue that constitutes the central focus of the following section on Decision-Oriented Foresight.

2.3. Decision-Oriented Foresight: From Scenario Construction to Strategic Choice

Strategic Foresight has traditionally focused on expanding decision-makers' understanding of uncertainty by constructing multiple plausible futures rather than predicting

a single outcome. This orientation has significantly strengthened organizations' capacity to anticipate change, challenge prevailing assumptions, and broaden strategic conversations. However, as foresight has matured, an important conceptual limitation has become increasingly evident: the production of alternative scenarios does not, by itself, indicate which future should become the basis for collective strategic action (Amer et al., 2013).

This limitation reflects a broader tendency within the foresight literature to privilege exploration over commitment. Hines et al. (2024) argues that scenarios are valuable because they reveal different archetypal patterns of future development, enabling decision-makers to recognize alternative trajectories rather than converge immediately on a preferred future. While this exploratory function constitutes one of foresight's greatest strengths, it also leaves unresolved the practical challenge of determining which scenario should guide institutional investment, public policy, and long-term strategic planning when several plausible alternatives coexist.

Recent developments in futures research increasingly suggest that the value of foresight should be assessed not only by its capacity to imagine futures, but also by its contribution to organizational learning and strategic action. Fergnani (2022) argues that future-oriented practices become strategically relevant when they influence how organizations interpret uncertainty, revise assumptions, and support decision-making processes. Similarly, recent empirical evidence demonstrates that the integration of Strategic Foresight into organizational decision-making contributes to improving planning quality, strengthening strategic alignment, and enhancing organizational performance across different institutional contexts (Alajrab et al., 2025). From this perspective, foresight should not conclude with the production of scenarios but should facilitate the transition from anticipation to coordinated action.

The growing demand for more actionable foresight has also exposed the need for greater methodological transparency in the evaluation of alternative futures. Although scenarios frequently stimulate dialogue among stakeholders, the criteria through which one future becomes strategically preferable often remain implicit or dependent on subjective judgment. Meissner (2013) emphasizes that scenario-based planning creates value when it provides a structured basis for comparing strategic alternatives rather than merely generating narratives about possible futures. Likewise, Dörr et al. (2024) observe that one of the principal barriers preventing foresight from generating organizational impact is the absence of systematic mechanisms capable of translating exploratory exercises into operational

decisions. Consequently, strengthening methodological transparency has become a central challenge for advancing foresight practice.

This challenge becomes particularly significant in entrepreneurial ecosystems, where governments, universities, firms, investors, and civil society frequently pursue different priorities and development expectations. Under these conditions, selecting a preferred future requires analytical processes capable of combining scientific rigor with participatory legitimacy. Earlier studies on entrepreneurial ecosystems highlighted that entrepreneurship policy frequently suffers from fragmented institutional coordination and limited strategic integration among ecosystem actors (Amorós & Bosma, 2014). Consequently, the selection of a preferred future cannot depend exclusively on intuitive consensus but instead requires explicit evaluation criteria capable of supporting transparent and collectively legitimized strategic decisions.

Building upon these developments, this study adopts a decision-oriented foresight perspective that explicitly distinguishes three complementary stages within the foresight process: the construction of alternative futures, the participatory definition of strategic evaluation criteria, and the transparent prioritization of competing scenarios. Rather than treating scenario development as the final outcome of foresight, the proposed framework conceives scenarios as inputs for subsequent decision-making processes supported by structured expert judgment and multi-criteria evaluation. This perspective shifts the emphasis from asking what futures are possible to determining which future should be collectively pursued.

Accordingly, the framework proposed in this article extends conventional scenario planning by connecting anticipatory thinking with strategic commitment and implementation. The integration of participatory evaluation, multi-criteria decision analysis, and subsequent roadmapping seeks to strengthen the decision value of Strategic Foresight while improving the legitimacy, transparency, and traceability of long-term strategic choices. In doing so, the article contributes to an emerging stream of futures research that increasingly conceives foresight not merely as a discipline for exploring uncertainty, but as a systematic methodology for supporting evidence-informed and collectively legitimate strategic decisions under conditions of complexity (Barbosa et al., 2024).

3. RESEARCH METHOD AND TECHNIQUES

3.1. Research Design

To address the research objective, this study adopted an applied, prospective, and qualitative research design based on an expert-oriented methodological approach. The research integrates qualitative foresight methods with structured multi-criteria decision analysis to support strategic decision-making under conditions of uncertainty, where scenario exploration alone is insufficient to identify a preferred future (Amer et al., 2013).

The proposed design combines complementary analytical techniques with distinct but interconnected functions. Causal Layered Analysis (CLA) was employed to construct alternative future scenarios by examining the structural, systemic, cultural, and worldview dimensions of the entrepreneurial ecosystem (Inayatullah, 2008). These scenarios were subsequently evaluated using the Régnier Abacus and the Analytic Hierarchy Process (AHP), allowing the transparent prioritization of alternative futures through structured expert judgment (Brunelli, 2015). Finally, the selected scenario was operationalized through a backcasting approach supported by Technology Roadmapping to define a strategic pathway from the present to the preferred future (Phaal et al., 2004).

This methodological integration constitutes the central research design of the study by connecting scenario construction, scenario evaluation, and strategic implementation within a single decision-oriented foresight framework.

3.2. Expert Panel Selection

The study employed an expert-based approach because prospective research addressing long-term uncertainty relies on informed judgment to evaluate future developments that cannot be empirically observed. Accordingly, purposive sampling was used to select specialists with recognized experience in entrepreneurship, innovation, technology transfer, public policy, higher education, and Strategic Foresight.

The objective was to assemble a multidisciplinary panel capable of assessing the future evolution of Ecuador's science- and technology-based entrepreneurial ecosystem from complementary institutional perspectives. Consequently, the panel included representatives from academia, government, the productive sector, entrepreneurial support organizations, and innovation-related institutions.

Data were collected through structured expert consultation during the successive stages of the research. Experts participated in the construction of scenarios, the identification

of evaluation criteria, the pairwise comparison of scenarios, and the validation of the resulting strategic roadmap, providing both qualitative judgments and quantitative assessments required for the analytical procedures.

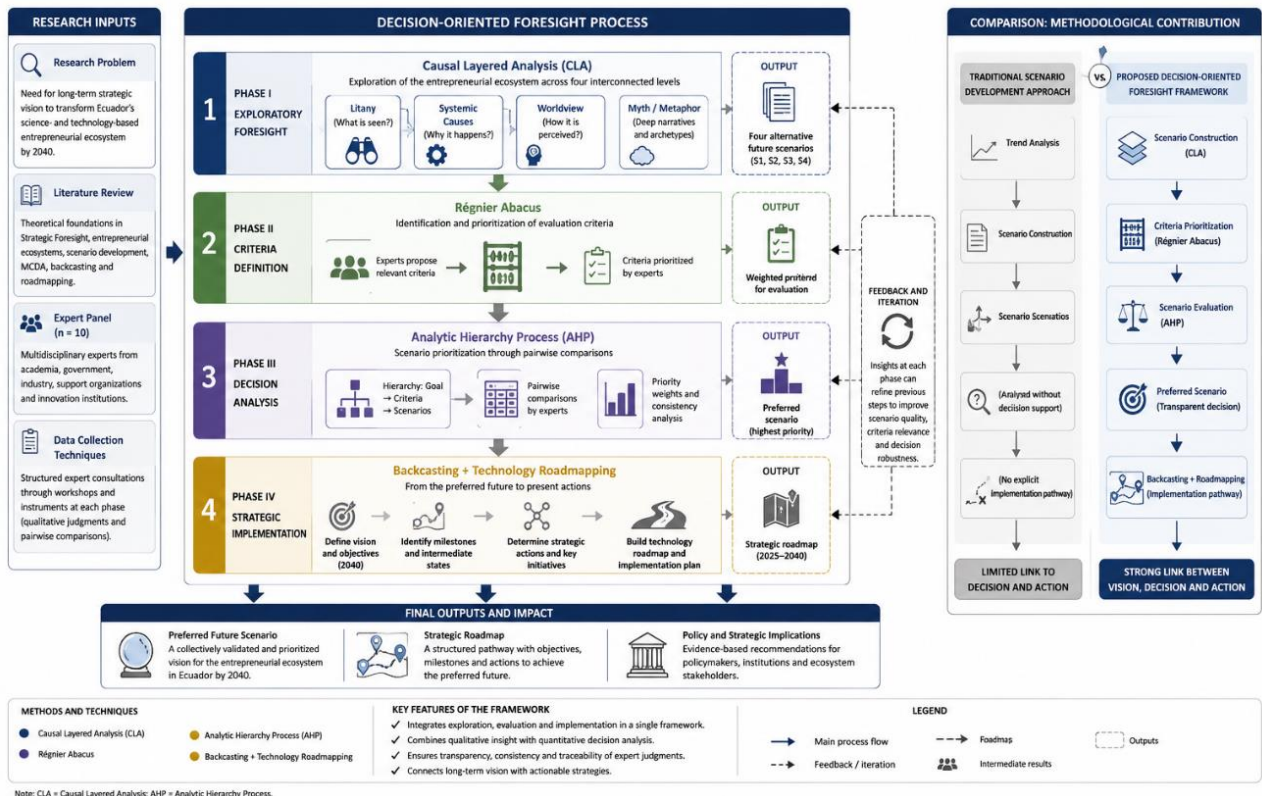
To ensure the reliability of expert judgments, participant competence was evaluated using the Expert Competence Coefficient (K) proposed by Cabero-Almenara and Llorente-Cejudo (2013). The coefficient was calculated as $K = (K_c + K_a) / 2$, combining self-assessed knowledge with the argumentation derived from professional experience, academic expertise, and practical involvement in the research topic. Competence was classified as high when $K > 0.80$, medium when $0.50 < K \leq 0.80$, and low when $K \leq 0.50$. Accordingly, the inclusion criterion was standardized as $K > 0.80$ so that only candidates in the high-competence category were retained; boundary values of $K = 0.80$ were therefore excluded.

The final panel consisted of 12 experts, who participated throughout all research stages. Maintaining the same panel across the complete research process strengthened the consistency of expert judgments and ensured methodological coherence.

3.3. Research Procedure

Fig. 1 illustrates the methodological workflow adopted in this study.

Figure 1: Decision-oriented foresight framework for scenario selection and strategic implementation



Source: Authors' elaboration.

The research procedure comprised four sequential phases, in which the outputs generated at each stage served as inputs for the subsequent phase.

In the first phase, Causal Layered Analysis (CLA) was conducted with the expert panel to explore the future of Ecuador's science- and technology-based entrepreneurial ecosystem across the litany, systemic causes, worldview, and myth/metaphor levels (Inayatullah, 2008). This phase resulted in the development of four alternative future scenarios.

In the second phase, the Régnier Abacus was applied to identify and prioritize the evaluation criteria proposed by the experts. These criteria constituted the decision framework for the subsequent assessment of the scenarios.

In the third phase, the Analytic Hierarchy Process (AHP) was employed to prioritize the four scenarios through pairwise comparisons based on the selected evaluation criteria (Brunelli, 2015). The consistency ratio of expert judgments was verified following the recommendations of Ishizaka and Labib (2011) before establishing the final scenario ranking.

In the fourth phase, the preferred scenario was operationalized through a backcasting approach supported by Technology Roadmapping (Phaal et al., 2004). This phase defined the strategic objectives, milestones, and actions required to achieve the selected future scenario.

3.4. Ethical Considerations

Participation in the study was voluntary. All experts were informed of the research objectives, the procedures involved, and the intended use of the information provided before participating in the study. Individual responses were treated confidentially, and the results are reported in aggregated form to preserve participants' anonymity and ensure compliance with the principles of informed consent, confidentiality, and responsible research practice.

4. RESULTS AND DISCUSSION

4.1. Results

The expert panel convened for this study comprised high-level professionals specializing in entrepreneurship, innovation systems, strategic foresight, and economic policy. Participants included university professors, senior policymakers, startup incubator directors, and economic development consultants. Over 80% held doctoral degrees, while the remainder combined postgraduate education with extensive leadership experience.

To validate their suitability, the competence coefficient (K) was calculated by averaging the Knowledge Coefficient (Kc) and Argumentation Coefficient (Ka), following the

procedure described above. Of the 15 initial candidates, 12 met the predefined inclusion criterion ($K > 0.80$) and were retained. The three candidates who did not meet the criterion were Experts 1 and 14, both with $K = 0.80$, and Expert 6, with $K = 0.65$. Competence scores among the retained experts ranged from 0.85 to 0.95, with Experts 2, 9, and 15 reaching the highest scores ($K = 0.95$).

The final panel's average competence coefficient was 0.89, reflecting consistently high epistemic reliability. Their diverse institutional affiliations and professional trajectories enriched the multidimensional analysis of Ecuador's entrepreneurial ecosystem toward 2040 (Table 1).

Table 1: Assessment of Expert Suitability (K Coefficient Method)

Expert	Knowledge Coefficient (Kc)	Argumentation Coefficient (Ka)	Competence Coefficient (K)	Rating
1	0.80	0.80	0.80	Medium
2	1.00	0.90	0.95	High
3	0.80	0.90	0.85	High
4	0.80	0.90	0.85	High
5	0.90	0.90	0.90	High
6	0.60	0.70	0.65	Medium
7	0.80	1.00	0.90	High
8	0.80	0.90	0.85	High
9	1.00	0.90	0.95	High
10	0.90	0.80	0.85	High
11	0.80	0.90	0.85	High
12	0.90	0.90	0.90	High
13	0.80	0.90	0.85	High
14	0.80	0.80	0.80	Medium
15	1.00	0.90	0.95	High

Note. $K = (Kc + Ka) / 2$. High competence: $K > 0.80$; medium competence: $0.50 < K \leq 0.80$; low competence: $K \leq 0.50$. The inclusion criterion was $K > 0.80$. Source: Authors' own elaboration.

In the Deepening the Future phase, the application of Causal Layered Analysis (CLA) enabled the panel to transcend surface-level metrics and explore the systemic, cultural, and symbolic structures shaping Ecuador's entrepreneurial ecosystem. By systematically working through the four analytical layers—litany, systemic causes, worldview, and myths/metaphors—the experts revealed how deep-seated constraints continue to limit the ecosystem's evolution toward a knowledge-driven model. This multilayered diagnosis brought to light not only factual indicators such as necessity-driven entrepreneurship and low

R&D investment but also dominant cultural narratives that reinforce dependency and inhibit innovation. The key findings extracted from each analytical layer are summarized below in Table 2.

Table 2: Systemic Diagnosis of Ecuador’s Entrepreneurial Ecosystem Using Causal Layered Analysis

Layer	Current Problems Identified
Litany	- Ecuador exhibits a high Early-Stage Entrepreneurial Activity Rate (TEA) of 32.7%, yet 90% of entrepreneurs are driven by necessity rather than opportunity (GEM, 2023). - Fear of failure affects 38% of the adult population, limiting entrepreneurial initiatives. - Only 14% of early-stage entrepreneurs possess higher education, constraining innovation potential. - Cumulative R&D investment between 2007 and 2018 (\$175 million) remains low, with little measurable impact on technological advancement. - Informality dominates the entrepreneurial landscape, restricting access to financing and institutional support.
Systemic Causes	- The national education system offers limited emphasis on STEM disciplines, resulting in a workforce with insufficient technical skills. - Chronic underinvestment in research, development, and innovation weakens the foundation for knowledge-based entrepreneurship. - Entrepreneurs face structural barriers to financing, especially in sectors requiring technological sophistication. - Regulatory environments are characterized by bureaucratic complexity, deterring formalization and business scalability. - Entrepreneurship policy is fragmented and lacks continuity across political cycles.
Worldview	- Entrepreneurship is widely perceived as a survival strategy rather than a catalyst for innovation and structural transformation. - There is a prevailing belief that meaningful innovation must be imported, undermining confidence in local capabilities. - Fear of failure reinforces conservative, low-risk entrepreneurial behavior. - Success is culturally associated with informal trade and artisanal endeavors, rather than scalable innovation.
Myths and Metaphors	- "The Artisan Entrepreneur": The dominant entrepreneurial archetype remains the small merchant or craftsman, emphasizing subsistence over innovation. - "Imported Innovation": Deep-seated narratives suggest that true technological progress comes from abroad.

Source: Authors’ own elaboration with support from the expert panel.

Building upon the critical diagnosis of Ecuador's entrepreneurial ecosystem, four alternative future scenarios were developed to explore distinct strategic responses to the structural, cultural, and symbolic constraints identified through Causal Layered Analysis (CLA). Each scenario articulates a differentiated approach, addressing the litany, systemic causes, worldview, and underlying metaphors that currently inhibit the ecosystem's evolution.

Rather than prescribing a singular developmental pathway, these scenarios aim to expand the range of plausible and desirable transformations by incorporating diverse

institutional, cultural, and territorial logics. This methodological design responds to the complexity and multi-causality revealed during the diagnostic phase, ensuring that alternative trajectories are both analytically coherent and contextually grounded.

The scenarios were structured to emphasize complementary yet distinct dynamics of change. Scenario 1 envisions a democratization of entrepreneurial opportunities through inclusive policies; Scenario 2 proposes a deliberate shift toward a science- and technology-based entrepreneurial model; Scenario 3 focuses on the territorialization of entrepreneurship by empowering regional ecosystems; and Scenario 4 highlights the potential of public-private innovation alliances as engines of systemic transformation. The development of these scenarios across the four CLA layers enables a multi-depth exploration of change, recognizing that effective ecosystem transformation requires interventions at factual, systemic, cultural, and symbolic levels simultaneously. The synthesized solutions for each scenario are presented in Table 3.

Table 3: Structural and Narrative Composition of Future Scenarios Using Causal Layered Analysis

Layer	Scenario 1: Ecosystem of Inclusive Entrepreneurship	Scenario 2: Science- and Technology-Based Ecosystem	Scenario 3: Entrepreneurial Regionalization	Scenario 4: Public-Private Innovation Alliances
Litany	Increase financial inclusion, reduce entrepreneurship barriers in vulnerable populations.	Boost early-stage entrepreneurship in STEM sectors; increase R&D-driven startups.	Strengthen local entrepreneurship in secondary cities through territorial innovation programs.	Expand startup support through hybrid public-private accelerators nationwide.
Systemic Causes	Reform educational programs to foster entrepreneurial skills at the basic and secondary levels.	Increase R&D investment to 1.5% of GDP; create tech parks linked to universities.	Strengthen municipal capacity to promote localized entrepreneurial ecosystems.	Simplify public procurement rules to favor startups and technological innovators.
Worldview	Promote entrepreneurship as a path to social mobility and community development.	Reframe entrepreneurship as a generator of scientific and technological value; reposition failure as learning.	Reinforce territorial pride and regional identity in entrepreneurial narratives.	Position entrepreneurship as a dynamic collaboration between state, market, and civil society actors.
Myths and Metaphors	Shift from the "survival entrepreneur" to the "community builder" metaphor.	Replace the "artisan entrepreneur" with the "scientific entrepreneur" identity.	Establish the "local innovator" myth: innovation can originate anywhere, not only in large cities.	Promote the "entrepreneurial alliance" metaphor: transformation emerges from collective co-creation.

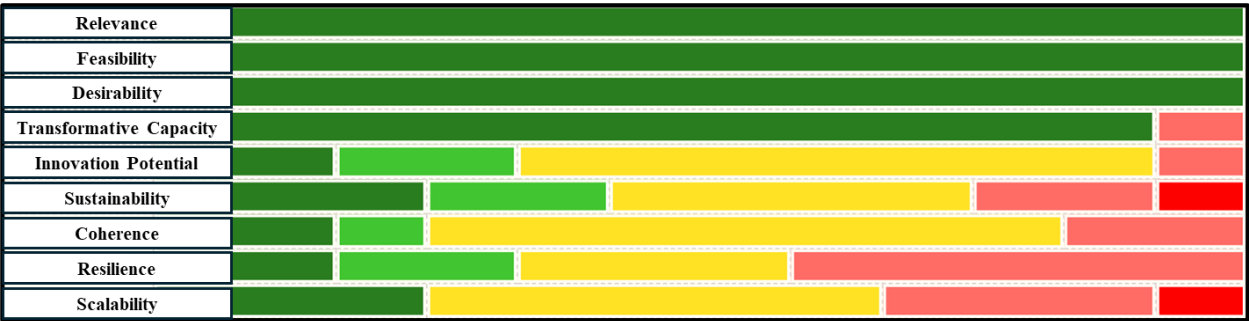
Source: Authors' own elaboration with support from the expert panel.

The prioritization of scenario evaluation criteria was conducted with twelve high-competence experts ($K > 0.80$) using the Régnier Abacus method. Full consensus was achieved for Relevance, Feasibility, and Desirability, with all experts assigning the highest level of agreement to these criteria.

Transformative Capacity also received strong support, with 11 of the 12 experts endorsing its inclusion as a strategic evaluation criterion. By contrast, Sustainability, Innovation Potential, Resilience, Internal Coherence, and Scalability received more heterogeneous assessments, reflecting lower levels of consensus among the panel.

Based on these results, the four criteria that achieved the highest levels of agreement—Relevance, Feasibility, Desirability, and Transformative Capacity—were selected for the subsequent Analytic Hierarchy Process (AHP), while the remaining criteria were excluded from the multi-criteria evaluation (Figure 2).

Figure 2: Prioritization of Strategic Scenario Evaluation Criteria Using the Régnier Abacus Method



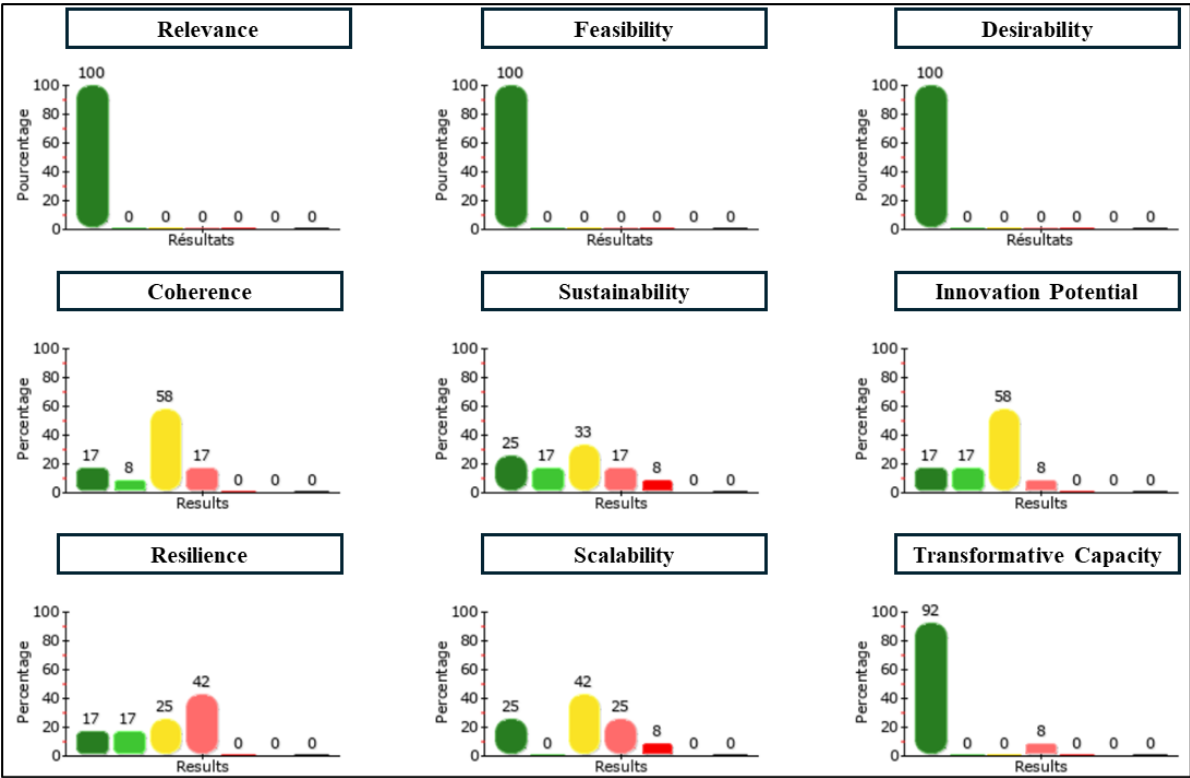
Source: Expert opinions collected via the Color Insight platform.

The Régnier Abacus results show a clear prioritization among the nine dimensions assessed for strategic scenarios toward 2040. Relevance, Feasibility, and Desirability received unanimous “Totally Agree” ratings, confirming Amer, Daim, and Jetter’s (2013) argument that scenarios must combine systemic alignment, viability, and societal resonance, as well as Ringland’s (2010) view on their role in mobilizing stakeholders. The consensus on Feasibility reinforces the need for scenarios to remain compatible with technological, economic, and political constraints (Amer et al., 2013), while the agreement on Desirability echoes Rohrbeck and Kum (2018), who highlight the importance of collective aspirations.

Transformative Capacity, though initially met with caution, was validated as decisive, in line with Barbosa et al. (2024), who stress its importance for overcoming structural inertia. By contrast, Sustainability, Innovation Potential, Resilience, Internal Coherence, and Scalability received more dispersed evaluations. While Dörr et al. (2024) and Alajrab et al.

(2025) acknowledge these as enhancers of robustness, their lower consensus suggests they are complementary rather than core. This refinement aligns with best practices emphasizing focus on decisive drivers (Hines et al., 2024) (Figure 3).

Figure 3: Visual Distribution of Expert Agreement Across Nine Scenario Evaluation Criteria



Source: Expert opinions collected via the Color Insight platform.

The pairwise comparison matrix between criteria showed that "Relevance" received the highest relative weight (45,45%), followed by "Transformative Capacity" (26,02%), "Feasibility" (18,35%), and "Desirability" (10,17%). This indicates that, for the expert panel, the structural alignment of the scenarios with the entrepreneurial ecosystem's key challenges is the most decisive attribute in the strategic evaluation. The consistency of the responses suggests a strong consensus regarding the importance of selecting scenarios that respond to the primary drivers shaping the future environment (Table 4).

Table 4: Pairwise Comparison Matrix Between Criteria

	Relevance	Feasibility	Desirability	Transformative Capacity	Normalized matrix				Average vector
Relevance	1	2	5	2	0,4545	0,3636	0,5000	0,5000	0,4545
Feasibility	0,5	1	2	0,5	0,2273	0,1818	0,2000	0,1250	0,1835
Desirability	0,2	0,5	1	0,5	0,0909	0,0909	0,1000	0,1250	0,1017
Transformative Capacity	0,5	2	2	1	0,2273	0,3636	0,2000	0,2500	0,2602
Sum	2,2	5,5	10	4					

Source: Authors’ own elaboration with support from the expert panel.

Regarding the "Relevance" criterion, the normalized matrix results showed that Scenario 2 achieved the highest priority average (48,83%), clearly outperforming the other alternatives. This outcome highlights that Scenario 2 is perceived as the most aligned with the structural forces expected to shape Ecuador's entrepreneurial ecosystem by 2040. "Scenario 1" and "Scenario 4" held moderate values, while "Scenario 3" exhibited the lowest relative alignment (Table 5).

Table 5: Pairwise Comparison Matrix for Each Criterion. Criterion: Relevance

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Normalized matrix				Average vector
Scenario 1	1	0,5	3	1	0,2308	0,2459	0,2727	0,1818	0,2328
Scenario 2	2	1	5	3	0,4615	0,4918	0,4545	0,5455	0,4883
Scenario 3	0,33	0,2	1	0,5	0,0769	0,0984	0,0909	0,0909	0,0893
Scenario 4	1	0,33	2	1	0,2308	0,1639	0,1818	0,1818	0,1896
Sum	4,3	2	11	5,5					

Source: Authors’ own elaboration with support from the expert panel.

Under the "Feasibility" criterion, Scenario 2 once again obtained the highest weight (38,29%), indicating that it was considered the most viable in terms of political, economic, social, and technological feasibility. "Scenario 4" followed in second place, suggesting an acceptable level of implementability. This reinforces the operational robustness of Scenario 2, validating its applicability in highly complex and dynamic contexts (Table 6).

Table 6: Pairwise Comparison Matrix for Each Criterion. Criterion: Feasibility

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Normalized matrix				Average vector
Scenario 1	1	0,33	1	0,5	0,1429	0,1250	0,1250	0,1765	0,1423
Scenario 2	3	1	3	1	0,4286	0,3750	0,3750	0,3529	0,3829
Scenario 3	1	0,33	1	0,33	0,1429	0,1250	0,1250	0,1176	0,1276
Scenario 4	2	1	3	1	0,2857	0,3750	0,3750	0,3529	0,3472
Sum	7,0	3	8	2,8					

Source: Authors’ own elaboration with support from the expert panel (2026).

Concerning the "Desirability" criterion, which measures societal attractiveness and stakeholder preference, Scenario 4 emerged as the most desirable, achieving an average priority of 48,83%, followed by Scenario 2 and Scenario 3. These findings suggest that while Scenario 2 is stronger in relevance and feasibility, other alternatives, particularly Scenario 4, exhibit greater emotional and aspirational resonance among ecosystem actors (Table 7).

Table 7: Pairwise Comparison Matrix for Each Criterion. Criterion: Desirability

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Normalized matrix				Average vector
Scenario 1	1	0,33	0,5	0,2	0,0909	0,0625	0,1111	0,0984	0,0907
Scenario 2	3	1	1	0,33	0,2727	0,1875	0,2222	0,1639	0,2116
Scenario 3	2	1	1	0,5	0,1818	0,1875	0,2222	0,2459	0,2094
Scenario 4	5	3	2	1	0,4545	0,5625	0,4444	0,4918	0,4883
Sum	11,0	5	5	2,0					

Source: Authors’ own elaboration with support from the expert panel.

For the "Transformative Capacity" criterion, Scenario 3 achieved the highest weight (44,87%), indicating its strong potential to induce deep structural changes in the entrepreneurial system. Scenario 4 also demonstrated considerable transformative capacity (36,39%). These results complement the overall perspective that, while Scenario 2 offers operational advantages, other scenarios may be critical to driving systemic change over the long term (Table 8).

Table 8: Pairwise Comparison Matrix for Each Criterion. Criterion: Transformative Capacity

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Normalized matrix				Average vector
Scenario 1	1	3	0,2	0,33	0,1071	0,1875	0,0854	0,1316	0,1279
Scenario 2	0,33	1	0,14	0,2	0,0357	0,0625	0,0610	0,0789	0,0595
Scenario 3	5	7	1	1	0,5357	0,4375	0,4268	0,3947	0,4487
Scenario 4	3	5	1	1	0,3214	0,3125	0,4268	0,3947	0,3639
Sum	9,3	16	2	2,5					

Source: Authors' own elaboration with support from the expert panel.

The synthesis of all individual matrices into the Global Weighted Priority Matrix determined that Scenario 2 obtained the highest overall priority (32,9%), establishing it as the most robust strategic bet. It was followed by Scenario 4 (29,4%) and Scenario 3 (20,2%), with Scenario 1 ranking last (17,4%). These results integrate relevance, feasibility, desirability, and transformative capacity, ensuring that the final scenario selection reflects a balanced and methodologically grounded strategic vision (Table 9).

Table 9: Global Weighted Priority Matrix for Strategic Scenario Determination

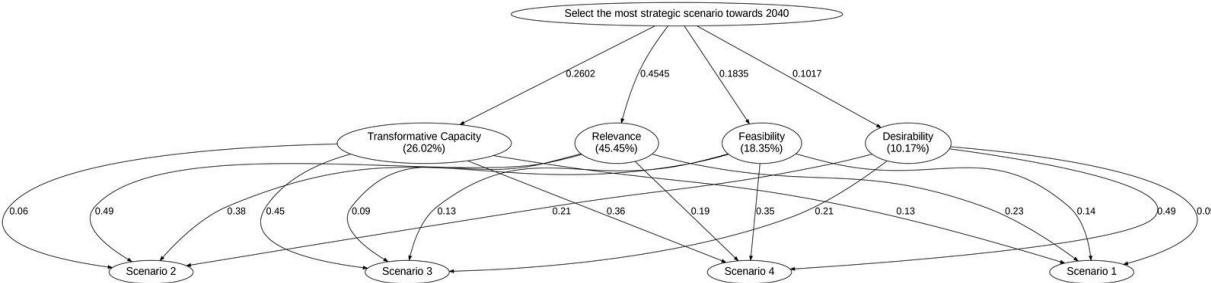
	Relevance	Feasibility	Desirability	Transformative Capacity	Total
Scenario 1	0,232804081	0,142331933	0,090720214	0,127896915	0,174
Scenario 2	0,488335435	0,382878151	0,21159598	0,059534316	0,329
Scenario 3	0,089275479	0,12762605	0,209360511	0,448695099	0,202
Scenario 4	0,189585005	0,347163866	0,488323294	0,36387367	0,294
Weighting	0,454545455	0,183522727	0,101704545	0,260227273	

Source: Authors' own elaboration with support from the expert panel.

The final AHP structure articulates the weighted relationships among criteria and scenarios. At the top level, four criteria—Relevance (45,45%), Transformative Capacity (26,02%), Feasibility (18,35%), and Desirability (10,17%)—were linked to the overarching goal: selecting the most strategic scenario for 2040. Each scenario's performance was evaluated through local priority scores. Scenario 2 emerged as dominant, especially in relevance (0,4883) and feasibility (0,3829), while Scenario 4 stood out in desirability and feasibility, positioning it as a viable alternative.

The hierarchical model (Figure 4) enhances traceability and interpretability, showing how expert judgments converged into a robust prioritization. Although Scenario 2 did not lead in transformative capacity, its selection reflects a trade-off between ambition and feasibility. Experts emphasized its alignment with policy, institutional viability, and short-term implementation potential, despite its moderate disruptive reach compared to Scenario 3. Scenario 2 assumes that structural change requires targeted institutional reform, cross-sector coordination, and cultural shifts, rather than solely relying on R&D investment. These preconditions are embedded in the roadmap through safeguards, adaptive mechanisms, and checkpoints.

Figure 4: Global Hierarchical Model Result



Source: Authors' own elaboration with support from the expert panel.

The consistency of the AHP model was assessed using the maximum eigenvalue ($\lambda_{\max}$), the Consistency Index (CI), and the Consistency Ratio (CR). The results yielded $\lambda_{\max} = 4.067$, $CI = 0.0223$, and $CR = 0.0248$, remaining below the recommended threshold of 0.10.

Based on the prioritized scenario, a strategic roadmap was developed to guide the transformation of Ecuador's entrepreneurial ecosystem toward 2040. The roadmap was structured into three planning horizons: short-term (2025–2030), focused on the implementation of a national innovation strategy; medium-term (2031–2035), aimed at strengthening regional entrepreneurial ecosystems; and long-term (2036–2040), oriented toward consolidating a science- and technology-based entrepreneurial ecosystem. Each horizon specifies strategic actions, responsible actors, and key performance indicators (KPIs), as summarized in Table 10.

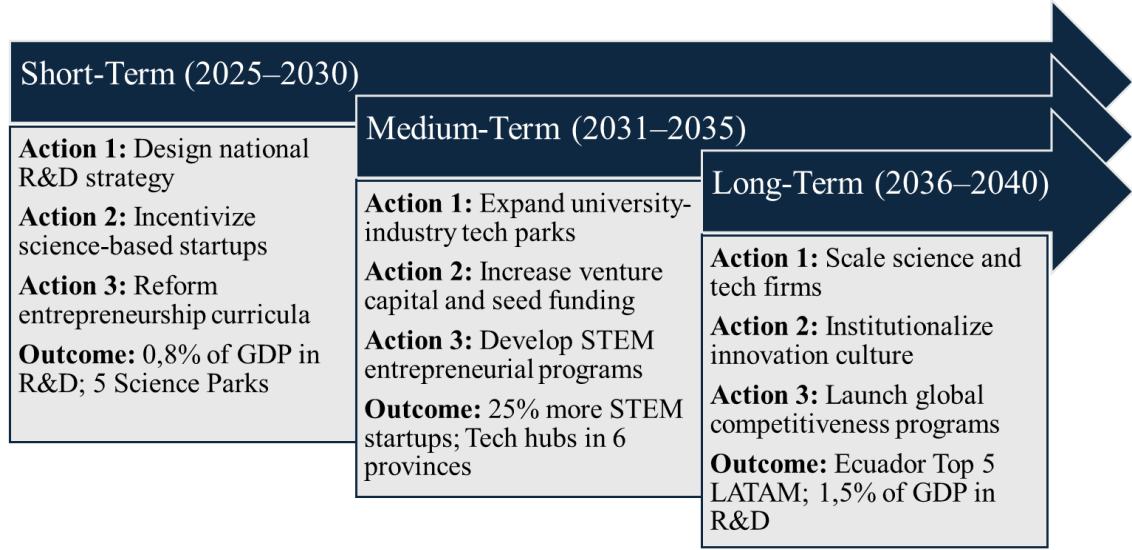
Table 10: Strategic Roadmap for the Transformation of Ecuador’s Entrepreneurial Ecosystem Toward 2040

Time Horizon	Key Milestone	Strategic Actions	Responsible Actors	Key Performance Indicators (KPIs)
2025–2030 (Short-Term)	National Innovation Strategy launched	- Design national R&D strategy- Incentivize creation of science-based startups- Reform entrepreneurship curricula in schools	Ministry of Production and Innovation, SENESCYT, Universities	National R&D investment reaches 0.8% of GDP; Launch of 5 science parks
2031–2035 (Medium-Term)	Strengthened regional innovation ecosystems	- Consolidate university-industry tech parks- Expand seed and venture capital programs- Develop STEM-focused entrepreneurial programs	Universities, Local Governments, Private Funds	STEM-based startup rate increases by 25%; Regional tech hubs operational in 6 provinces
2036–2040 (Long-Term)	Consolidated Science and Technology-Based Ecosystem	- Scale national network of science and tech firms- Institutionalize innovation culture initiatives- Launch global competitiveness programs	National Innovation Council, Chambers of Commerce, International Partners	Ecuador ranks in Top 5 innovation ecosystems in LATAM; 1.5% of GDP invested in R&D

Source: Authors’ own elaboration with support from the expert panel.

This roadmap was complemented by a visual timeline (Figure 5) that depicts the phased progression of key milestones, with critical transitions and enabling conditions highlighted across the three planning horizons.

Figure 5: Visual Timeline of Strategic Milestones and Transitions Toward 2040



Source: Authors’ own elaboration with support from the expert panel.

The roadmap articulates a phased transformation of Ecuador’s entrepreneurial ecosystem toward 2040, balancing foresight with actionable milestones. In the short term

(2025–2030), it calls for a national R&D strategy, incentives for science-based startups, and curriculum reform, aiming for 0,8% of GDP in R&D and five science parks. The medium term (2031–2035) prioritizes expanding university–industry tech parks, strengthening venture capital, and developing STEM programs, targeting a 25% increase in STEM startups and innovation hubs in six provinces. By 2036–2040, the focus shifts to scaling science-based firms, institutionalizing innovation culture, and launching competitiveness programs, positioning Ecuador among the top five innovation ecosystems in Latin America. Comparative experiences reinforce the roadmap’s plausibility when governance, education, and culture align coherently.

4.2. Discussion

The findings demonstrate that the contribution of the proposed framework extends beyond the construction of alternative futures by introducing a transparent and systematic process for identifying the scenario that should guide long-term strategic action. While Strategic Foresight has traditionally emphasized the exploration of uncertainty through scenario development, comparatively less attention has been devoted to the methodological transition between generating plausible futures and selecting a preferred future capable of supporting collective decision-making (Amer et al., 2013). The integration of Causal Layered Analysis (CLA), the Régnier Abacus, the Analytic Hierarchy Process (AHP), and Strategic Roadmapping addresses this limitation by connecting exploration, evaluation, prioritization, and implementation within a single methodological sequence. Consequently, the study reinforces the view that the value of foresight lies not only in anticipating alternative futures but also in improving the quality and legitimacy of strategic decisions (Rohrbeck & Kum, 2018).

One of the most significant findings emerged from the prioritization of evaluation criteria. Although transformational change is frequently presented as the primary aspiration of futures-oriented interventions, the expert panel assigned the greatest decision weight to Relevance (45.45%), followed by Transformative Capacity (26.02%), Feasibility (18.35%), and finally Desirability (10.17%). This hierarchy suggests that, when experts evaluate long-term transformations of entrepreneurial ecosystems, they do not necessarily privilege the most attractive or visionary future. Instead, they prioritize scenarios capable of addressing the structural problems that currently constrain ecosystem performance. This finding expands the discussion proposed by Rohrbeck and Kum (2018), who argue that foresight creates organizational value when it supports strategic action, by showing that the perceived

relevance of a scenario may outweigh its aspirational appeal during collective decision-making.

The relatively low weight assigned to desirability deserves particular attention. Scenario planning frequently assumes that preferred futures emerge from shared aspirations; however, the present findings indicate that experts distinguished clearly between what is desirable and what is strategically necessary. This distinction becomes especially important in entrepreneurial ecosystems characterized by institutional weaknesses, where highly desirable futures may not represent the most appropriate pathway for long-term transformation. Rather than selecting the future that generated the greatest normative appeal, participants favored the scenario that best responded to the ecosystem's structural deficiencies. This result suggests that decision-oriented foresight should balance normative aspirations with strategic realism, thereby complementing approaches that focus primarily on envisioning desirable futures (Inayatullah, 2008).

The prioritization of Scenario 2, centred on the transition toward a science- and technology-based entrepreneurial ecosystem, further strengthens this interpretation. Interestingly, this scenario was not selected because it represented the most transformative alternative. In fact, Scenario 3 obtained the highest score for Transformative Capacity, while Scenario 4 was considered the most desirable by the expert panel. Nevertheless, neither achieved the highest overall priority once all evaluation criteria were simultaneously considered through the AHP. This finding challenges the implicit assumption that the future offering the greatest degree of transformation should necessarily become the preferred future. Instead, the results indicate that preferred futures emerge from balancing strategic relevance, implementation feasibility, and transformational potential rather than maximizing a single attribute. In this sense, the application of AHP contributed not only to ranking alternatives but also to making explicit the trade-offs inherent in strategic decision-making, thereby extending the use of multi-criteria analysis within Strategic Foresight (Saaty, 1980).

The results obtained through CLA also provide important insights into the nature of entrepreneurial ecosystem transformation. Rather than identifying isolated institutional barriers, the four analytical layers revealed that many of Ecuador's structural constraints originate from deeply embedded cultural narratives and collective assumptions regarding entrepreneurship, innovation, and development. This finding reinforces the central premise of CLA that sustainable transformation requires interventions extending beyond the litany and systemic levels to address worldviews and underlying myths (Inayatullah, 2008). Consequently, policies focused exclusively on financing entrepreneurship or strengthening

innovation infrastructure are unlikely to generate lasting systemic change unless they are accompanied by initiatives capable of transforming the cultural narratives that shape entrepreneurial behaviour.

Another relevant contribution concerns the role of the Régnier Abacus within the methodological framework. Rather than functioning merely as a preliminary consultation tool, the Abacus enabled the systematic refinement of evaluation criteria before the application of AHP. The reduction from nine initial criteria to four strategically validated dimensions simplified the subsequent prioritization process while preserving the diversity of expert perspectives. This sequential integration illustrates how qualitative expert judgement can be progressively translated into structured decision variables without losing transparency or methodological coherence. Therefore, the value of the framework lies not only in combining different foresight techniques but also in assigning each method a complementary analytical function within the overall decision process.

From a theoretical perspective, the study contributes to Strategic Foresight by distinguishing three analytical stages that are frequently treated as a single activity in previous research: the construction of scenarios, the evaluation of scenarios, and the implementation of the preferred scenario. Existing studies have significantly advanced the development of scenario-building methodologies (Amer et al., 2013); however, comparatively fewer have proposed explicit procedures for justifying why one scenario should guide strategic action. The framework proposed here addresses this gap by demonstrating that the legitimacy of a preferred future can be strengthened through transparent evaluation criteria, structured multi-criteria analysis, and explicit links between scenario selection and strategic implementation. Accordingly, the principal methodological contribution of the study does not reside in introducing new foresight tools, but in integrating established methods into a coherent decision-support architecture.

The findings also generate important implications for entrepreneurial ecosystem research. Much of the literature has concentrated on explaining how interactions among institutions, entrepreneurs, universities, governments, and support organizations influence ecosystem performance (Stam, 2015). The present study complements this perspective by demonstrating that ecosystem transformation depends not only on understanding these interactions but also on establishing mechanisms capable of supporting collective strategic choice under conditions of uncertainty. In this regard, the proposed framework shifts the emphasis from diagnosing ecosystem dynamics toward governing future transitions, thereby

extending the practical application of entrepreneurial ecosystem theory within long-term innovation policy.

Finally, the proposed framework offers practical implications for policymakers responsible for designing innovation and entrepreneurship strategies. By documenting how alternative futures are evaluated, prioritized, and translated into strategic roadmaps, the approach enhances transparency, accountability, and stakeholder participation throughout the foresight process. Rather than relying solely on intuitive consensus regarding desirable futures, public decision-makers can justify long-term strategic choices through explicit criteria and reproducible analytical procedures. Although the framework was applied to Ecuador's science- and technology-based entrepreneurial ecosystem, its methodological logic may be transferable to other complex policy domains requiring long-term planning, multiple stakeholders, and evidence-informed strategic decisions.

5. CONCLUSION

This study proposed and validated a decision-oriented foresight framework for supporting the long-term transformation of entrepreneurial ecosystems through the integration of Causal Layered Analysis, the Régnier Abacus, the Analytic Hierarchy Process, and Strategic Roadmapping. Applied to Ecuador's science- and technology-based entrepreneurial ecosystem, the framework enabled the systematic construction, evaluation, prioritization, and operationalization of alternative futures within a single methodological process. Rather than concluding with the identification of plausible scenarios, the proposed approach demonstrated how foresight can support transparent strategic decision-making by explicitly connecting scenario development with scenario selection and implementation.

Scientific contributions. The findings show that the selection of a preferred future cannot be explained solely by transformative potential or normative desirability. Experts prioritized the scenario that achieved the strongest balance between strategic relevance, feasibility, and transformational capacity, demonstrating that long-term decisions in complex entrepreneurial ecosystems depend on multiple complementary dimensions rather than on maximizing a single attribute. The study therefore contributes empirical evidence that preferred futures emerge through structured evaluation processes capable of making expert judgment explicit, transparent, and reproducible.

Methodological contributions to Futures Studies. The study demonstrates the complementarity of four well-established methods within an integrated decision-support architecture. Causal Layered Analysis reveals structural, cultural, and symbolic drivers; the

Régnier Abacus systematically refines evaluation criteria; the Analytic Hierarchy Process transparently prioritizes competing futures; and Strategic Roadmapping translates the selected scenario into an actionable implementation pathway. The framework's originality resides in integrating these methods into a coherent sequence that reduces the gap between anticipatory analysis and strategic action.

Practical implications for policymakers. The framework provides governments, universities, innovation agencies, and other ecosystem actors with an explicit procedure for evaluating competing futures and documenting the rationale underlying strategic choices. This strengthens transparency, facilitates stakeholder participation, and supports the design of long-term innovation policies. Beyond Ecuador, the methodological logic may assist policymakers in other countries and regions seeking to align entrepreneurial development with science, technology, and innovation agendas under uncertainty.

Research limitations. The empirical application relied on expert judgment within Ecuador and therefore reflects the institutional characteristics, governance structures, and development priorities of a single national ecosystem. Although the methodological framework is transferable, the prioritization of scenarios and evaluation criteria cannot be directly generalized to other territorial or sectoral contexts without adaptation. The study is also a prospective assessment rather than a longitudinal evaluation of policy implementation, so the long-term effectiveness of the proposed roadmap remains to be empirically validated.

Recommendations for future research. Future studies should apply the framework to different entrepreneurial ecosystems, compare scenario prioritization across countries and regions, and incorporate additional decision-support techniques for uncertainty under alternative governance settings. Comparative research should also test whether expert groups in different institutional environments assign similar importance to relevance, feasibility, desirability, and transformative capacity. Such work would advance Strategic Foresight from an exploratory discipline centered on imagining futures toward a decision-oriented discipline capable of supporting legitimate, transparent, and implementable long-term transformations.

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