

The AI-Enhanced Opportunity Nexus: How Artificial Intelligence is Reshaping Entrepreneurial Problem Ideation

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ABSTRACT

Entrepreneurs increasingly adopt artificial intelligence (AI) tools during the earliest stage of venture creation—problem ideation. To clarify how AI reshapes this stage of opportunity identification, this study conducts a systematic scoping review of emerging literature. Searches were performed in Google Scholar and Scopus using Boolean queries combining “artificial intelligence,” “entrepreneurship,” “opportunity identification,” and “ideation.” After removing duplicates and screening records against predefined inclusion and exclusion criteria, 17 studies were included. Data were extracted using a structured coding framework capturing the entrepreneurial stage, AI’s functional role, reported benefits and risks, and boundary conditions. Findings show that AI expands entrepreneurs’ cognitive search space, accelerates pattern recognition, and supports reframing of problem domains, but also introduces risks of convergence, reduced contextual judgment, and overreliance. Synthesizing these patterns, the review develops the AI-Enhanced Opportunity Identification Framework: Human–AI Co-Evolutionary Extension, a refinement of a foundational opportunity identification model. The framework identifies three cross-stage AI roles—Inspirer, Analyst, and Organizer—and situates ideation within iterative human–AI collaboration shaped by institutional enablers such as AI-integrated incubators. This review contributes by mapping empirical evidence on AI’s influence on entrepreneurial ideation, clarifying mechanisms of human–AI co-creation, and outlining future research opportunities on judgment, novelty, and ecosystem-level effects.

Keywords: artificial intelligence; entrepreneurship; opportunity identification; problem ideation; human–AI collaboration; systematic scoping review

INTRODUCTION

Artificial intelligence (AI) is rapidly reshaping how entrepreneurs identify and frame problems, a foundational step in opportunity identification. Problem

ideation traditionally relied on human cognition—intuition, network-generated insight, lived experience, and effectual reasoning using the “means at hand” (1). These approaches remain essential but are slow, bound, and susceptible to individual biases. AI introduces new forms of search and synthesis by scanning large datasets, detecting anomalies, and generating alternative framings (2). Yet the same capabilities heighten concerns that algorithmic convergence may reduce originality and weaken entrepreneurs’ independent judgment, especially as founders increasingly rely on similar tools trained on overlapping data. Understanding how AI expands,

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Accepted December 29, 2025

<https://doi.org/10.70251/HYJR2348.41152164>

redirects, or constrains the ideation process is therefore critical for entrepreneurship theory and practice.

As AI diffuses across entrepreneurial ecosystems, its influence extends beyond individual cognition to institutional and societal levels. Entrepreneurs must balance efficiency gains with autonomy and contextual sensitivity; investors face challenges differentiating genuinely novel ideas from algorithmically produced ones; and educators and incubators increasingly embed AI into curricula and venture-development programs (3). These shifts position AI not only as a cognitive aid but also as an institutional enabler that shapes how problem spaces are discovered, constructed, and evaluated. The effects of AI on ideation appear highly contingent: its value is greatest in early-stage ventures where speed and breadth matter, and among founders capable of critically assessing AI outputs. In contrast, problems requiring tacit cultural understanding or narrative legitimacy remain difficult for AI to support effectively.

Scholars disagree on whether AI ultimately enables or constrains entrepreneurial ideation. Some highlight its democratizing and performance-enhancing effects (2, 4), while others warn that excessive reliance on data-driven systems may narrow opportunity recognition and weaken intuition (5, 6). These competing interpretations underscore the need for an integrative framework that clarifies when and how AI supports discovery, creation, and exploration in entrepreneurship.

This review addresses this gap by synthesizing evidence from 17 studies to develop the AI-Enhanced Opportunity Identification Framework: Human–AI Co-Evolutionary Extension of Ardichvili *et al.* (2). The framework integrates insights from effectuation, discovery versus creation, and exploration versus exploitation to explain how AI functions as an Inspirer, Analyst, and Organizer throughout the ideation process. It also identifies boundary conditions and institutional enablers that shape the quality and originality of AI-supported problem framing.

The review makes three contributions. First, it consolidates fragmented research into a coherent account of AI's enabling and constraining effects on entrepreneurial ideation. Second, it connects these effects to foundational entrepreneurship theories, showing how AI alters core cognitive mechanisms. Third, it highlights gaps related to cognitive dependency, ethical risks, and educational design. The sections that follow describe the review methodology, present findings across ideation stages, and discuss implications for entrepreneurs, educators, and policymakers.

METHODS AND MATERIALS

This study employed a systematic scoping review to synthesize how artificial intelligence (AI) influences entrepreneurial problem ideation and the earliest phases of opportunity identification. A scoping approach was chosen because research on AI in entrepreneurship is conceptually fragmented, spans multiple disciplines, and includes both foundational theoretical work and rapidly emerging empirical studies. Scoping reviews are well suited to clarifying broad conceptual domains, mapping evolving literatures, and identifying theoretical and empirical gaps without requiring statistical aggregation.

Searches were conducted in Google Scholar and Scopus, using combinations of terms such as “artificial intelligence” and entrepreneurship, “AI” and “opportunity identification,” “AI” and ideation, and “human–AI collaboration” and creativity. No publication date limits were applied. Foundational theories of entrepreneurial cognition and opportunity processes [e.g., 1; 7] were considered essential to interpreting how AI reshapes entrepreneurial search and decision-making. Restricting the timeframe would have excluded these theoretical anchors, so all eligible literature from earliest database coverage through 2025 was included.

Studies were considered for inclusion if they examined AI, machine learning, or generative AI in an entrepreneurial, opportunity-identification, or ideation context, and if they provided conceptual or empirical insight into problem recognition, framing, or early opportunity development. Only peer-reviewed, English-language studies were included. Articles were excluded if they addressed AI without connecting it to entrepreneurial cognition or opportunity processes, if they focused primarily on corporate automation or operational efficiency rather than entrepreneurship, or if they lacked methodological detail or offered only anecdotal commentary. Non-peer-reviewed working papers and duplicates were also excluded.

Screening was conducted by a single reviewer. Titles and abstracts were first examined to determine whether studies addressed entrepreneurship and AI in a meaningful way. Full texts were then reviewed to assess eligibility more closely. During a second-pass review, several conceptual commentaries and papers with insufficient methodological transparency were excluded to maintain rigor and focus. The screening process resulted in a final sample of 17 studies. The search produced approximately 450 records; after removing around 75 duplicates, 375 titles and abstracts were

screened. Roughly 40 studies were reviewed at the full-text stage, with 23 excluded for insufficient relevance or methodological clarity.

Each included study was read in full and summarized for its research context, methodological approach, and main findings. A structured spreadsheet was used to extract information on the entrepreneurial stage addressed, the functional role of AI in the study (such as augmenting human cognition, generating ideas, analyzing information, or organizing knowledge), the benefits and risks associated with AI use, and the relevant boundary conditions (including founder expertise, venture stage, data availability, and institutional environment). Coded entries were revisited after one week to reduce interpretive drift, and ambiguous findings were re-examined within their full context to ensure consistency. No framework dimensions were imposed prior to coding; categories and relationships were refined iteratively as recurring patterns emerged across the included studies.

During synthesis, empirical studies, particularly those employing experiments, case studies, surveys, or mixed-methods approaches, were given slightly greater interpretive weight when assessing AI's actual behavioral or cognitive effects. Conceptual and theoretical contributions were used primarily to clarify constructions, identify mechanisms, and establish boundary conditions. This weighting allowed the review to remain grounded in observed evidence while integrating a broader theoretical foundation.

The framework developed in this study, the AI-Enhanced Opportunity Identification Framework: Human–AI Co-Evolutionary Extension, emerged

through iterative integration of theory and evidence. The initial structure was adapted from Ardichvili *et al.*'s (2) opportunity-identification model, but the framework was refined inductively as consistent patterns appeared across the 17 coded studies. This hybrid development process aligns with scoping-review conventions, where frameworks may evolve during synthesis rather than being predetermined.

RESULTS

The analysis synthesizes findings from the 17 included studies, integrating evidence across the seven stages of the AI-Enhanced Opportunity Identification Framework. This section reports a structured synthesis of findings from the 17 included studies, organized by framework stage and the coded dimensions described in the Methods (AI role, benefits/risks, and boundary conditions). Interpretive integration with entrepreneurship theory is reserved for the subsequent Analysis section. Study characteristics and coded dimensions are summarized in Table 1. Across the dataset, consistent patterns emerged regarding AI's functional roles, benefits, risks, and boundary conditions. Most studies emphasized AI's value in expanding search breadth, accelerating recognition of latent patterns, and increasing ideational throughput. Fewer studies explicitly examined risks or institutional contingencies, though those that did highlighted concerns about convergence, overreliance, and diminished contextual sensitivity. The following sections present these findings stage by stage, drawing on the coded evidence.

Table 1. Evidence Matrix Summarizing Study Design, AI Mechanisms, and Key Findings Across the 17 Included Studies. The table summarizes study design, context, framework stage(s), AI mechanisms, and key findings across the 17 included studies.

Citation (Year)	Method / Design	Context	Framework Stage(s)	AI Mechanism	Key Finding / Contribution
Giuggioli & Pellegrini (8)	Systematic literature review	Entrepreneurship	Antecedents → Ideation	Knowledge extension; clustering	AI extends entrepreneurs' domain awareness and accelerates opportunity discovery.
Uriarte <i>et al.</i> (20)	Hybrid literature review	Global startups	All	Generative AI + analytics integration	AI democratizes entrepreneurship and reduces early-stage information barriers.
Shepherd & Majchrzak (17)	Conceptual	Digital entrepreneurship	Antecedents	Boundary-spanning AI	AI functions as partner extending entrepreneurs' "means set."

Continued Table 1. Evidence Matrix Summarizing Study Design, AI Mechanisms, and Key Findings Across the 17 Included Studies. The table summarizes study design, context, framework stage(s), AI mechanisms, and key findings across the 17 included studies.

Citation (Year)	Method / Design	Context	Framework Stage(s)	AI Mechanism	Key Finding / Contribution
von Krogh <i>et al.</i> (22)	Conceptual / Case	Research & Innovation contexts	Pattern Recognition → Learning	Formative discovery	AI supports recombination of ideas and iterative learning loops.
Joosten <i>et al.</i> (10)	Experiment	Product ideation	Pattern Recognition → Evaluation	LLM-generated ideas	AI ideas match or exceed human novelty; similar feasibility.
Shaer <i>et al.</i> (16)	Experiment	Group ideation	Creative Framing	AI-augmented brainwriting	More diverse and original ideas than human-only groups.
van Oudheusden & Willebrand (21)	Conceptual / Case	Design thinking	Creative Framing → Action	AI as co-founder	AI stimulates divergent framings in design processes.
Lehmann <i>et al.</i> (11)	Case + Survey	Corporate ideation	All stages	Inspirer / Analyst / Evaluator agents	AI increases efficiency and cross-team coordination.
Just <i>et al.</i> (9)	Experiment	Ideation search	Scanning	AI clustering	AI broadens search field and identifies weak signals.
Puapongsakorn & Brazdeikyte (12)	Case	Swedish startups	Action	Prototyping support	AI accelerates MVP development cycles.
Puranam <i>et al.</i> (13)	Experiment	Strategy decision-making	Pattern Recognition	Analogical reasoning	LLMs enhance cross-domain analogy formation.
Puranam <i>et al.</i> (14)	Conceptual / Case	Collective problem-solving	Ideation → Action	Digital heterarchy	AI mediates distributed collaboration among teams.
Trzcielinski (18)	Comparative analysis	Human vs AI ideation	Learning	Complementary cognition	Humans add context; AI adds consistency—synergistic learning.
Thottoli <i>et al.</i> (19)	Case	Entrepreneurship education	Action	AI mentoring	AI incubators improve feedback speed and venture progress.
Sarasvathy (1); Ardichvili <i>et al.</i> (2); Davidsson (3)	Foundational theory	Entrepreneurship	Framework base	Conceptual	Provide theoretical grounding for model stages.

The model extends Ardichvili *et al.*'s (2) opportunity identification cycle by incorporating algorithmic, institutional, and human–AI co-creative dynamics. Institutional enablers (AI-integrated incubation centers) shape actor antecedents, while AI functions operate across cognitive stages as inspirer, analyst, and organizer agents. Generative-AI tools such as LLM-augmented brainwriting—structured group ideation sessions where participants build on AI-generated prompts and

one another's responses—enhance creative framing and evaluation, and AI's co-founder role accelerates prototyping and feedback. Human reflection maintains ensemble balance and ethical oversight, completing a co-evolutionary learning loop between humans, AI, and the entrepreneurial ecosystem. *Note. Framework synthesized by the author, integrating opportunity identification theory with empirical findings from the reviewed literature.*

Actor Antecedents and External Enablers

According to the studies included, AI strengthens antecedents by augmenting entrepreneurs' access to knowledge and cognitive bandwidth. Several empirical and conceptual studies (2, 17, 6) describe AI as a knowledge-extending or boundary-spanning mechanism that broadens entrepreneurs' initial awareness of opportunity spaces. These studies show that AI enables faster assimilation of novel information and supports early-stage sensemaking. Consistent with Table 1, this enabling effect functions primarily through AI's analyst role, in which algorithms surface weak signals and reduce informational constraints.

Institutional enablers also appeared as antecedents in a subset of studies. (3) highlighted AI-integrated incubation and educational platforms that embed algorithmic prompting, mentoring, and project-scaffolding tools into entrepreneurial learning. These findings indicate that entrepreneurial antecedents are now shaped not only by human experience and networks but also by organizational and institutional infrastructures that mediate access to AI tools. Across studies, boundary conditions emphasized in this stage included domain knowledge, digital literacy, and the presence of supportive institutional environments.

Scanning and Attention

Table 1 shows that studies examining scanning consistently found that AI expands entrepreneurs' perceptual field. Experiments by Just *et al.* (9) and analyses by Uriarte *et al.* (20) demonstrated that AI tools automate aspects of environmental scanning by aggregating and clustering diverse data sources. Puranam *et al.* (14) identified AI as a proxy for distributed attention, capable of integrating perspectives across domains that individual entrepreneurs may overlook. Together, these findings suggest that AI functions primarily as an attentional amplifier, enhancing the speed and breadth of opportunity scanning. Boundary conditions at this stage included data quality, model training context, and entrepreneurs' ability to critically evaluate AI-directed cues.

Pattern Recognition and Recombination

Pattern recognition emerged as one of the most empirically supported benefits of AI across the dataset. Table 1 indicates that multiple experiments and case studies document AI's role in identifying non-obvious relationships and enabling novel recombinations. Joosten *et al.* (10) showed that AI-generated ideas often match or

exceed human ideas in novelty and feasibility. Lehmann *et al.* (11) described algorithms that reveal correlations between customer needs and technological affordances that humans may not detect. Puranam *et al.* (13) found that LLMs enhance analogical reasoning across distant domains. Across these findings, AI plays a dual role as analyst and inspirer, increasing the variety and depth of candidate insights while leaving final interpretive judgment to the entrepreneur. Risks noted in this stage include potential homogenization when relying on similar prompting structures across users.

Creative Framing and Ideation

Several studies provided strong empirical and conceptual evidence on AI's impact in the ideation stage. Experiments by Shaer *et al.* (16) demonstrated that AI-augmented brainwriting increases novelty and diversity of ideas compared to human-only groups. Van Oudheusden and Willebrand (21) described AI as a co-founder within design-thinking workflows, generating alternative framings that support divergent exploration. Giuggioli and Pellegrini (8) and Puranam *et al.* (14) further highlighted AI's role in reframing problem boundaries, constructing personas, and stimulating creative counterfactuals. These contributions align with the inspirer and organizer roles coded in Table 1. At this stage, boundary conditions often related to founder expertise, prompting skill, and the team's ability to iterate effectively with algorithmic suggestions. While increased ideational throughput was widely observed, several studies cautioned that alignment with human values and contextual relevance remains essential to maintaining originality.

Evaluation and Opportunity Confidence

Studies addressing evaluation consistently found that AI improves efficiency and decision confidence. Lehmann *et al.* (11) documented AI-driven scoring systems that help founders triage large idea sets. Joosten *et al.* (10) found that generative-AI users reached consensus on promising ideas more quickly without sacrificing creative diversity. Townsend and Hunt (5) and Von Krogh *et al.* (22), however, warned that structured algorithmic feedback may overly stabilize early judgments, leading founders to prematurely discard unconventional ideas. Across the dataset, AI's analyst and evaluator roles support rapid assessment, but effective use requires human oversight to balance efficiency with exploration. Boundary conditions included founders' risk tolerance and ability to interpret algorithmic rationale.

Opportunity Development and Action

AI's influence extended meaningfully into opportunity development and enactment. Case studies by Puapongsakorn and Brazdeikyte (12), Lehmann *et al.* (11), and Puranam *et al.* (14) showed that AI accelerates prototyping, facilitates cross-team coordination, and enables distributed collaboration through shared digital artifacts. Thottoli *et al.* (19) added that AI-enabled incubators provide structured feedback loops that speed venture development. These findings indicate that AI serves as an organizational integrator, supporting movement from ideation toward implementation. Consistent with Table 1, institutional support structures play an increasingly influential role at this stage, shaping how algorithmic insights translate into actionable entrepreneurial steps.

Outcomes and Learning

The final stage concerns how entrepreneurs and organizations learn from AI-assisted ideation cycles. Trzcielinski (18) found that humans and AI contribute complementary strengths to learning: humans provide contextual and experiential grounding, while AI supplies breadth, consistency, and feedback data. Lehmann *et al.* (11) observed that organizations employing AI-based ideation systems accumulate “institutional memory” that refines future opportunity search. Von Krogh *et al.* (22) noted that iterative interaction with AI accelerates recognition of new opportunity spaces, reinforcing the feedback loop described in Figure 1. Learning operates on individual, algorithmic, and institutional levels, demonstrating the co-evolutionary dynamics central to the reviewed framework.

A comparative summary of how entrepreneurial ideation practices differ before and after AI integration across framework stages is presented in Table 2.

DISCUSSION

This section interprets the reviewed evidence through three central theoretical lenses in entrepreneurship: effectuation theory (1), opportunity discovery versus creation (2, 6), and exploration versus exploitation (7)—while grounding the discussion in the seven stages of the AI-Enhanced Opportunity Nexus Framework. These frameworks collectively explain how entrepreneurs act under uncertainty, balance creative generation with refinement, and construct new opportunities from available means. Interpreting the findings through these lenses clarifies how AI alters the cognitive and behavioral

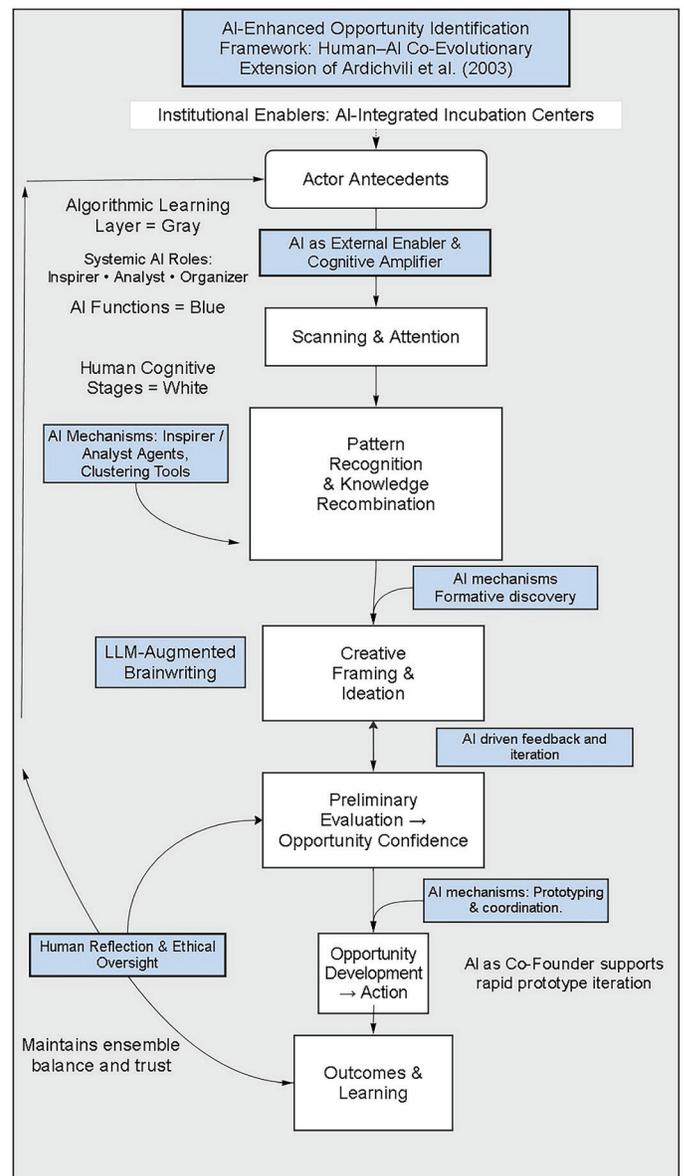


Figure 1. AI-Enhanced Opportunity Identification Framework.

mechanisms that drive each stage of problem ideation. The analysis reveals that AI functions simultaneously as an external enabler and a cognitive amplifier. It reshapes entrepreneurial ideation not by replacing human creativity but by modifying how entrepreneurs search, frame, evaluate, and learn. Overall, AI's influence can be characterized as generative augmentation: a positive-sum collaboration that expands problem-finding capacity while introducing new boundaries for critical judgment and originality. All analytic claims in this section derive from patterns observed across the coded findings of the

Table 2. Comparison of Pre-AI and AI-Enhanced Entrepreneurial Ideation Across Opportunity Identification Stages

Framework Stage	Pre-AI Dominant Practices	AI-Enhanced Practices	Observed Benefits	Risks / Mitigations
Actor Antecedents	Reliance on prior experience and networks	AI extends domain knowledge via data access	Broader knowledge base	Potential detachment from context → blend data with lived experience
Scanning & Attention	Manual environmental scanning	NLP clustering; AI search assistants	Faster recognition of trends	Over-filtering → maintain manual review
Pattern Recognition & Recombination	Intuition & analogy from experience	ML pattern mining; LLM analogical reasoning	Reveals hidden links	Homogenization → diversify data sources
Creative Framing & Ideation	Brainstorming, narrative reasoning	Generative co-creation, AI-brainwriting	↑ Novelty & idea variety	Over-reliance → human evaluation checkpoints
Evaluation → Confidence	Heuristic scoring; intuition	Algorithmic scoring + simulation	↑ Speed, objectivity	Premature convergence → human oversight
Development → Action	Manual prototyping, coordination	AI prototyping + project planning	Faster iteration & team alignment	Coordination overload → clear role division
Outcomes & Learning	Reflective journaling & post-mortems	Data capture & feedback systems	Institutionalized learning	Reinforcement bias → periodic human audits

included studies, as summarized in Table 1, rather than from external or speculative theorizing.

AI and Effectuation: From “Means at Hand” to “Means in Mind”

Effectuation describes entrepreneurial action as beginning with the resources immediately available: that is, the entrepreneur’s identity, knowledge, and social network (1). In this logic, opportunity identification is emergent, iterative, and anchored in personal context. AI introduces a new category of means: what the algorithm knows.

Across the reviewed studies, this shift is visible from the first stage of the framework—Actor Antecedents and External Enablers. Founders now augment their personal knowledge with algorithmic knowledge bases, gaining instant access to market data, technological trends, and analogies from distant domains. Giuggioli and Pellegrini (8) call this knowledge extension, while Shepherd and Majchrzak (17) view it as a boundary-spanning collaboration that widens the entrepreneur’s “means set.”

This infusion of algorithmic means changes in how effectuation works in practice. Entrepreneurs can now test “what-if” scenarios before acting, shifting part of effectuation’s improvisational experimentation into virtual space. Instead of building ventures purely from

resources at hand, they combine tangible experience with simulated knowledge—turning effectuation into a hybrid process of co-creation between human and algorithm. Recent evidence reframes this hybridity more concretely: AI can act as a co-founder that accelerates all design-thinking stages while moving founders between participatory and supervisory roles depending on task complexity (21). Field experiments further show that entrepreneurs who flexibly alternate between Centaurs—dividing tasks with AI—and Cyborgs—fully integrated workflows—achieve superior performance (24). These patterns illustrate adaptive effectuation, in which entrepreneurs continually renegotiate what counts as “means at hand” as intelligent tools expand both capability and constraint.

Yet this hybridization raises two interpretive tensions. First, if AI generates knowledge detached from the entrepreneur’s lived context, it may weaken the very effectual logic of grounded action. Second, reliance on algorithmic suggestions can subtly reintroduce prediction—something effectuation originally sought to avoid. Founders might increasingly trust data-driven forecasts, moving from control-based reasoning (“I shape the future I can control”) toward prediction-based reasoning (“the model foresees likely futures”). Maintaining effectual integrity thus requires

entrepreneurs to treat AI as an exploratory partner rather than an oracle.

Discovery versus Creation: Balancing Efficiency and Originality

Building on Davidsson (3), opportunity identification can be viewed through three constructs—External Enablers, New Venture Ideas, and Opportunity Confidence, which clarify how AI shapes both the environment and cognition of entrepreneurs. This framing extends Ardichvili *et al.*'s (2) cycle by showing that AI operates as an external enabler that broadens feasible combinations and as a cognitive partner that influences entrepreneurs' confidence in their interpretations.

AI's power in scanning and pattern recognition accelerates discovery. Systems described by Just *et al.* (9) and Lehmann *et al.* (11) rapidly detect anomalies, unmet needs, and cross-domain analogies. This automation transforms discovery from a serendipitous event into a systematic capability. Entrepreneurs no longer rely solely on intuition or network cues; they can generate evidence-based hypotheses on a scale. Puranam *et al.* (13) provides direct empirical support: users aided by large language models produced analogies spanning greater conceptual distances than human-only controls. Such findings demonstrate AI's capacity to expand discovery by surfacing opportunities invisible through human search alone. Yet many analogies were shallow or decontextualized, underscoring that AI broadens reach but still relies on human judgment to ensure depth and relevance.

By contrast, opportunity creation remains more dependent on human agency. Generative tools support creative framing (16, 21) but still draw from historical data. They can remix patterns, not originate the unprecedented. Creation in the entrepreneurial sense often requires emotional resonance, legitimacy narratives, and contextual interpretation—domains where human intuition prevails. However, the studies suggest that AI can stimulate creation indirectly by providing conceptual raw material. Entrepreneurs use generative systems to build metaphors, explore counterfactuals, and challenge assumptions. These mechanisms align with von Krogh *et al.*'s (22) notion of formative discovery, where machine output seeds human imagination. Comparative research supports this hybrid model: while AI contributes speed and pattern recognition, humans supply contextual judgment and meaning, together forming a hybrid cognition that strengthens both discovery and creation (18).

Across the discovery-creation continuum, AI's impact can be summarized as asymmetric amplification: discovery becomes faster and broader, while creation becomes more reflective and iterative. Entrepreneurs oscillate between algorithmic exploration and human reframing. The resulting balance determines originality. Excessive reliance on discovery tools risks homogenization, but disciplined alternation—where humans reinterpret machine outputs—preserves creative distinctiveness.

Exploration versus Exploitation: Reconfiguring the Search Frontier

March's (7) exploration–exploitation framework clarifies how AI changes the structure of entrepreneurial search. Traditional ventures struggle to balance exploratory experimentation with exploitative refinement. The reviewed literature shows that AI compresses this tension by making exploration more accessible and exploitation more precisely.

Generative models act as divergence engines. Shaer *et al.* (16) find that AI-augmented brainstorming expands the variety of ideas produced per session. Uriarte *et al.* (20) report that founders can test multiple conceptual directions in parallel, lowering the cost of experimentation. Through iterative prompting, entrepreneurs engage in rapid cycles of variation and feedback—essentially low-cost exploration loops. Experiments on AI-augmented brainwriting confirm these dynamics, showing that LLM collaboration widens divergent search while structured AI feedback aids convergence (16). Likewise, human–AI ensembles outperform either agent alone when their errors differ, yielding a balanced exploration–exploitation mix (23).

Simultaneously, AI enhances exploitation by providing real-time evaluation and prioritization. Lehmann *et al.* (11) describe scoring systems that rank ideas by novelty and feasibility, helping teams converge efficiently. Townsend and Hunt (5) note that structured feedback reduces decision fatigue, improving execution discipline. These systems transform exploitation from an intuition-driven activity into a semi-automated optimization process.

The interplay of exploration and exploitation manifests vividly in Stage 5 (Evaluation) of the framework. Entrepreneurs use AI both to expand the search frontier and to filter it. This dual use challenges the traditional sequential logic—explore first, exploit later. Instead, AI enables simultaneous exploration–exploitation, a hallmark of adaptive cognition. The risk, however, is premature convergence: algorithms favor

high-probability ideas, potentially discouraging radical innovation. Studies recommend counter-balancing mechanisms such as divergent prompting and human-in-the-loop vetting to maintain search diversity.

Cognitive Amplification Across Stages

Integrating these theoretical perspectives reveals AI's deeper role: it reconfigures the cognitive architecture of entrepreneurship. Each stage in the framework demonstrates a distinct mode of augmentation.

Learning: Continuous feedback loops embed entrepreneurial experience into data infrastructures, generating institutionalized cognition. Together, these mechanisms form what Lehmann *et al.* (11) call a human–AI hybrid cognitive system—one capable of combining human contextual reasoning with machine precision.

Emerging Risks and Boundary Conditions

Although the overall trajectory is positive, several boundaries temper AI's benefits. **Homogenization of Thought:** When many entrepreneurs query similar models trained on overlapping datasets, idea diversity narrows. Von Krogh *et al.* (22) and Puranam *et al.* (13) warn that identical prompts often yield convergent patterns. Maintaining originality requires personalization of data inputs and deliberate prompt variation.

Loss of Embodied Context

Effectuation depends on direct engagement with stakeholders and real-world feedback. Virtual ideation may detach founders from contextual nuance, weakening empathy and narrative legitimacy (5). Blending AI analysis with field interaction mitigates this effect. Empirical field data reinforce this concern: performance declines when entrepreneurs apply AI beyond its technological frontier, highlighting the limits of algorithmic generalization (24)

Algorithmic Overconfidence

Several studies (11, 10) note that entrepreneurs often over-trust AI's evaluative precision. Transparency about data sources and model assumptions is essential to prevent premature commitment to flawed concepts. **Data Inequities:** Access to advanced AI platforms varies by geography and resources. Uriarte *et al.* (20) highlight the risk of a new digital divide where well-resourced founders benefit disproportionately. Democratization therefore depends on open-source models and affordable computational access.

Ethical and Learning Feedback Loops

As AI captures more entrepreneurial data, proprietary learning systems may reinforce successful archetypes, reproducing biases in future ideation. Trzcielinski (18) calls this the “mirror effect,” wherein AI reflects historical successes rather than emerging social needs.

These conditions delineate the edges of AI's opportunity-enhancing potential and underscore the need for human critical oversight, particularly in stages of framing and evaluation.

Toward a Co-Evolutionary Model of Ideation

Synthesizing across theories and findings, AI's influence can be understood as a co-evolution between human cognition and machine computation. Entrepreneurs adapt their reasoning patterns to AI's affordances, while AI tools, trained on human-generated data, progressively internalize entrepreneurial heuristics. This reciprocal learning cycle aligns with the final stage of the framework, Outcomes and Learning, where experience feeds back into antecedents.

This reciprocal learning also reflects ensemble cognition (23) and situates AI within Davidsson's (3) external-enabler framework, where human intent and algorithmic patterning continually shape one another.

In this co-evolutionary system, AI and human entrepreneurs operate as interdependent agents within a continuous learning loop. AI expands perception by uncovering patterns and possibilities that humans might overlook, while entrepreneurs contribute intentionality—deciding which patterns hold meaning, value, and feasibility. Through this ongoing interaction, data, algorithms, and human imagination continually refine one another, producing a hybrid intelligence that evolves with each cycle of use and reflection.

This dynamic resolves a long-standing debate in entrepreneurship over whether opportunities are discovered within existing information structures or constructed through entrepreneurial action (2,3). Under AI augmentation, opportunities are co-constructed emerging from the interaction between human intent and machine patterning. The framework thus bridges discovery and creation perspectives through technological mediation.

Implications for the Framework

The analysis validates the logic of the AI-Enhanced Opportunity Nexus Framework while suggesting refinements for future research. First, feedback loops should be modeled not only between Outcomes and

Antecedents but also between Evaluation and Ideation, reflecting real-time learning in generative-AI contexts. Second, the framework could incorporate a “critical reflection” layer capturing ethical and contextual review, functions still uniquely human. Finally, empirical work should test the degree of cognitive amplification across contexts (e.g., novice versus expert founders, data-rich versus data-poor domains) to quantify where AI delivers the highest ideational leverage.

Practical Implications

This review shows that artificial intelligence (AI) is transforming entrepreneurial ideation from an intuitive, individual activity into a collaborative, data-informed, and increasingly democratized process. Across scanning, pattern recognition, and ideation, AI expands entrepreneurs’ cognitive reach and accelerates discovery without eroding autonomy—provided that reflective human oversight remains central. The evidence supports an overall optimistic conclusion: when paired with judgment and critical reflection, AI augments rather than replaces creativity.

The co-evolutionary framing clarifies that AI’s influence extends beyond cognition to systemic and institutional levels. Entrepreneurs now ideate within human–AI ensembles (23) supported by algorithmic tools, feedback systems, and incubator infrastructure. Generative models serve as co-founders that accelerate design-thinking stages (21) while educators and institutions provide scaffolding for ethics and skill development. This distributed structure links micro-level cognition with meso-level collaboration and macro-level learning—showing how opportunity identification evolves through co-adaptive interaction among humans, machines, and ecosystems.

For practitioners, AI extends entrepreneurial

cognition. Founders can use generative and analytic systems to broaden problem spaces, identify patterns, and accelerate early validation. The greatest impact occurs during early-stage opportunity identification, when uncertainty is high and time constraints are severe. Entrepreneurs should maintain a human-in-the-loop approach—treating AI as a catalyst for divergent thinking, not a decision authority. Documenting prompts, questioning outputs, and grounding algorithmic insights in field feedback help preserve creative autonomy and contextual relevance.

Educators can design AI-based ideation exercises that teach students to alternate between machine-generated prompts and human evaluation, mirroring AI-augmented brainwriting practices (16). Such activities strengthen students’ ability to balance exploration and exploitation while building AI literacy and ethical awareness. Incubators may adopt AI mentoring platforms (19) to scale feedback efficiently, but must ensure mentorship retains contextual nuance. More broadly, accessible AI tools reduce entry barriers and support inclusive entrepreneurship (20), provided that educators emphasize reflective use rather than automation. The practical implications of AI-enhanced opportunity ideation for educators, entrepreneurs, and policymakers are summarized in Table 3.

The AI-Enhanced Opportunity Nexus Framework offers a scaffold for empirical validation. Researchers can test which stages yield the greatest cognitive amplification, how founder expertise moderates outcomes, and whether algorithmic diversity predicts originality. Longitudinal studies should examine how entrepreneurs evolve their reasoning as AI systems mature, tracing the co-evolution of human and machine cognition across ventures and ecosystems. Experimental work could also explore ensemble dynamics—when and

Table 3. Practical Implications of AI-Enhanced Opportunity Ideation for Key Stakeholders

Stakeholder	Key Takeaways	Recommended Actions
Educators	AI literacy and creative reasoning must develop together.	Incorporate AI-assisted ideation labs pairing generative tools with peer critique. Train students to assess AI outputs for bias, originality, and context.
Entrepreneurs	AI broadens search and speeds testing but risks homogenization if used uncritically.	Use AI for divergent exploration, then apply human judgment for convergence. Keep reflective logs to capture learning from iteration.
Policymakers	AI democratizes idea generation but may reinforce digital divides.	Ensure equitable access to AI resources and promote open data. Support guidelines for responsible AI-driven entrepreneurship.

how human–AI collaboration outperforms either agent alone (23, 24).

Viewed through effectuation, discovery–creation, and exploration–exploitation lenses, the literature converges on three integrative insights. AI enhances effectual capacity by broadening entrepreneurs’ available means and enabling simulated experimentation. It favors discovery *yet also* stimulates creation, transforming ideation into a hybrid process of algorithmic suggestion and human reframing. Finally, AI compresses exploration and exploitation, allowing simultaneous divergence and convergence through iterative prompting and scoring. Together, these shifts mark a transition from entrepreneurial cognition to augmented entrepreneurial cognition, where human creativity remains central but operates through distributed human–AI systems.

Limitations

Several limitations temper the conclusions of this review. First, as a literature-based synthesis, the findings are inherently dependent on the quality, scope, and methodological rigor of the existing studies. Many of the included works rely on experimental designs or simulation-based evidence rather than field observations, which limits confidence in the real-world applicability of the reported effects. Second, the reviewed literature is temporally concentrated, with a strong emphasis on post-2020 research on generative AI. This concentration may overrepresent optimistic outcomes associated with early adoption and understate longer-term challenges or unintended consequences. Third, restricting the corpus to English-language publications introduces potential linguistic and cultural bias, as entrepreneurship practices and AI adoption dynamics may differ substantially in non-Western or resource-constrained contexts. Finally,

although structured coding procedures and theoretical triangulation were employed, interpretive subjectivity cannot be fully eliminated, and some degree of analytical bias may remain. Collectively, these limitations highlight the need for future research, particularly longitudinal field studies and cross-cultural investigations, to further test, refine, and extend the framework proposed in this review. A structured overview of the key limitations identified in the reviewed literature and corresponding directions for future research is provided in Table 4.

Despite these constraints, the convergence of results across theoretical and empirical sources provides robust evidence that AI serves as an enabling, rather than substituting, force in entrepreneurial ideation. The next section concludes the paper by integrating these insights and outlining the future trajectory of AI-augmented entrepreneurship.

CONCLUSION

This systematic review synthesized evidence from 17 peer-reviewed studies examining how artificial intelligence (AI) influences entrepreneurs’ problem ideation. Across the dataset, the findings consistently show that AI reshapes opportunity identification by expanding search breadth, accelerating pattern recognition, and increasing ideational throughput, while preserving the need for human interpretation and judgment. Rather than substituting for entrepreneurial creativity, AI most often functions as a complementary cognitive resource that alters how opportunities are recognized, framed, evaluated, and enacted.

The evidence synthesized across stages supports the AI-Enhanced Opportunity Identification Framework as a useful integrative lens. At early stages, AI strengthens

Table 4. Cognitive Functions of Artificial Intelligence Across Stages of Entrepreneurial Opportunity Identification

Stage	AI Function	Key Mechanism / Effect
Antecedents	Extends entrepreneurs’ memory and perception	Expands cognitive reach beyond human bandwidth
Scanning	Converts attention into a scalable resource	Enables persistent vigilance across information channels
Pattern Recognition	Transforms intuition into computational abduction	Infers hidden relationships algorithmically
Ideation	Acts as a synthetic collaborator	Enhances divergent thinking through prompt-response iteration
Evaluation	Provides predictive scoring and simulation	Supports structured, disciplined reflection
Action	Coordinates distributed contributors	Produces collective intelligence at the venture level

antecedents and scanning by lowering informational barriers and surfacing weak signals. During pattern recognition and ideation, experimental and case-based studies show that generative systems enhance recombination, analogical reasoning, and diversity of ideas. In evaluation and action stages, AI-supported scoring, prototyping, and coordination tools improve speed and confidence while facilitating faster learning cycles. These effects are strongest when entrepreneurs possess sufficient domain expertise to critically assess algorithmic outputs.

Across studies, benefits were contingent rather than universal. Several contributions identified risks associated with overreliance on algorithmic feedback, including convergence toward homogeneous ideas, reduced contextual sensitivity, and premature closure during evaluation. Boundary conditions repeatedly observed in the literature include data quality, prompting skill, founder experience, and institutional support structures such as AI-integrated incubators and educational platforms. Taken together, the evidence suggests that AI enhances ideation outcomes when used reflectively within human–AI ensembles but constrains originality when treated as an authoritative substitute for judgment.

Viewed through effectuation, discovery–creation, and exploration–exploitation perspectives, the literature converges on three evidence-based insights. First, AI expands entrepreneurs’ effectual means by enabling rapid experimentation and simulated learning. Second, AI supports both discovery and creation by generating candidate patterns that require human reframing to become meaningful opportunities. Third, AI compresses exploration and exploitation by enabling rapid divergence and convergence within the same ideation cycle. These mechanisms collectively point to a shift toward augmented entrepreneurial cognition, in which creativity remains human-led but is increasingly distributed across human and algorithmic agents.

This review contributes by consolidating fragmented findings into a coherent account of how AI alters entrepreneurial problem ideation across cognitive, organizational, and institutional levels. While the overall pattern of evidence supports AI as an enabling force, the literature remains uneven in its attention to long-term outcomes, ethical implications, and contextual variation. Future research would benefit from longitudinal field studies examining how AI-supported ideation affects venture performance, opportunity diversity, and ecosystem-level inclusion over time. Further empirical

testing of the proposed framework across industries, regions, and educational settings can clarify when AI enhances entrepreneurial creativity and when it risks narrowing the space of innovation.

ACKNOWLEDGEMENTS

The author gratefully acknowledges Julian Corj for mentorship and guidance throughout the development of this research. This work was conducted as part of the Empowerly Research Scholars Program.

CONFLICT OF INTEREST

The author declares no conflicts of interest related to this work.

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