A Conceptual Framework for AI-Supported Decision Making in Pre-Incubation Programmes

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Abstract. *Artificial intelligence (AI) offers significant opportunities to support the early-stage of entrepreneurial idea development as a part of pre-incubation programme. To examine current research in this area, a scoping literature review screened 289 records identified from Scopus and Web of Science, resulting in 20 studies for qualitative synthesis. Through a literature review, this paper addresses key research questions regarding the entrepreneurial stages, decision-making domains, AI technologies and approaches and system architectures related to the application of AI in decision-making within pre-incubation programs and early-stage idea development within higher education. Based on these insights, the paper develops a conceptual framework specifically tailored for AI-driven decision-making during these early phases of entrepreneurial idea development.*

Keywords. decision-making, pre-incubation, artificial Intelligence

1 Introduction

Universities are increasingly expected to contribute not only to education and research but also to innovation and regional economic development by fostering entrepreneurial competencies among students. Consequently, entrepreneurial idea development has become an important component of universities' third mission, encouraging higher education (HE) institutions to create environments that support entrepreneurial thinking, idea development and venture creation (Mele et al., 2022; Bielicki & Weinert, 2021; Wright et al., 2017).

Pre-incubation programmes have emerged as an important mechanism for supporting students during the earliest stages of entrepreneurial idea development. However, this phase is characterized by high uncertainty and numerous strategic decisions, including opportunity recognition, idea validation, business model development, partner selection and resource allocation. These decisions substantially influence subsequent venture development and entrepreneurial success (Kalisty, 2023; Bielicki, 2023). Consequently, improving the quality of entrepreneurial decision-making has become an increasingly important objective of university pre-incubation programmes.

Recent advances in AI create new opportunities to support entrepreneurial decision-making by providing data-driven insights, idea generation, information analysis and personalized recommendations (Shi et al., 2026; Qiu, 2024; Chen, 2026; Park, 2025). Nevertheless, existing research provides valuable but fragmented evidence on AI in entrepreneurship and HE, with relatively little attention devoted to a coherent conceptualisation of AI-supported decision-making throughout the university pre-incubation process.

To address this gap, this study systematically analyses existing literature on AI-supported decision-making in pre-incubation/entrepreneurship and HE through a scoping literature review and proposes a conceptual framework for AI-supported decision-making in university pre-incubation programmes.

2 Background

2.1 Pre-incubation as a Foundation for Entrepreneurial Development

Pre-incubation has become an increasingly important component of contemporary entrepreneurship education, serving as a bridge between entrepreneurial learning and formal business incubation. Unlike business incubators, which primarily support established ventures, pre-incubation focuses on the earliest stages of entrepreneurial development, where ideas are explored, evaluated, validated and gradually transformed into viable business opportunities (Mele et al., 2022).

Originally introduced as a preparatory stage for early-stage venture and student start-up development, pre-incubation has evolved beyond preparing ventures for incubation (Jones et al., 2013; Kalisty, 2023).

Contemporary programmes increasingly emphasise entrepreneurial learning, opportunity exploration, experimentation and the development of entrepreneurial capabilities that remain valuable regardless of whether participants ultimately establish a company (Bielicki, 2023).

Modern pre-incubation programmes typically combine multidisciplinary collaboration, experiential learning, mentoring, networking, challenge-based activities and increasingly AI-supported innovative teaching approaches. Participants work in interdisciplinary teams to develop and validate entrepreneurial ideas while receiving continuous feedback from mentors, academics, industry experts, and, increasingly, AI-supported learning environments that provide personalised guidance and decision support (Mele et al., 2022; Kadoić et al., 2026, Chen, 2025).

In addition, pre-incubation can be situated within a broader student start-up ecosystem. (Wright et al., 2017) argue that student entrepreneurship is supported not only through classroom-based entrepreneurship education, but also through experiential mechanisms, university support structures, pre-accelerators, accelerators, entrepreneurs, support actors, investors, funding mechanisms and the wider external context. This ecosystem perspective is relevant for pre-incubation because it highlights that student venture development depends on coordinated support from multiple actors rather than on isolated educational activities (Wright et al., 2017; Mele et al., 2022). Similarly, university business incubators facilitate collaboration between students, universities, companies, mentors and industry partners by providing networking opportunities, knowledge exchange, mentoring and access to entrepreneurial ecosystems (Kazhenov, 2023).

Accordingly, pre-incubation can be understood as a structured environment that supports entrepreneurial idea development while enabling participants to experiment, validate assumptions and prepare for subsequent incubation under conditions of uncertainty. Recent studies further suggest that embedding pre-incubation within formal university curricula provides students with a structured entrepreneurial pathway, guiding them through idea development, customer validation, business-model design, pitching and transition towards incubation or acceleration (Popov, 2022).

2.2 Decision-Making During Pre-incubation

The pre-incubation programme typically focuses on idea generation, problem-solution validation and initial market research to transform a raw concept into a structured business model. To facilitate this transformation, the program integrates structured training designed to elevate the teams' technological, business and entrepreneurial knowledge and skills, alongside personalized mentoring and coaching from industry experts to guide them through technical and market obstacles. Throughout all these stages and processes, generative artificial intelligence can be utilized as a valuable tool to support decision-making and enhance the learning experience (Kadoić et al., 2026; Shi et al., 2026).

During this stage, teams must decide precisely which core customer pain point they are solving and define their specific target market segment based on early validation data. They also need to determine the essential features required for their Minimum Viable Product (MVP) and evaluate whether the founding team possesses the right mix of skills to execute the vision. Ultimately, the final and most critical decision teams face at the end of pre-incubation is whether to refine the concept based on feedback, stop the project, or formally advance to the incubation and market-entry stage.

Unlike established organisations, early-stage entrepreneurial teams operate with limited information, knowledge and experience, evolving assumptions and constrained resources, requiring a continuous sequence of strategic and operational decisions throughout entrepreneurial idea development. These decisions are part of opportunity recognition, idea evaluation, business-model development, resource allocation, customer validation and readiness for incubation, all of which influence subsequent venture development (Kalisty, 2023; Mele et al., 2022).

The entrepreneurial process is inherently iterative. Consistent with lean startup and scientific approaches to entrepreneurship, entrepreneurs continuously formulate hypotheses, gather evidence, validate assumptions and refine or pivot their ideas as new information becomes available (Ries, 2011; Camuffo et al., 2024).

This perspective is consistent with decision-making theory, which conceptualises decision-making as a structured process involving problem identification, information gathering, evaluation of alternatives, implementation and continuous assessment (Taherdoost & Madanchian, 2023). In entrepreneurial settings, scientific approaches encourage entrepreneurs to reduce uncertainty by systematically formulating and testing hypotheses, gathering evidence and updating decisions before committing significant resources (Camuffo et al., 2024).

Despite these advances, the pre-incubation programme literature still predominantly describes educational activities, mentoring approaches and programme structures rather than conceptualising pre-incubation as an integrated entrepreneurial decision-making process. While individual activities such as idea generation, mentoring or business-model development are well represented, relatively little attention has been devoted to understanding how these activities collectively support interconnected

entrepreneurial decisions throughout the pre-incubation lifecycle (Kalisty, 2023; Mele et al., 2022).

2.3 Artificial Intelligence for Entrepreneurial Decision-Making

AI is increasingly transforming entrepreneurship by providing new opportunities to support entrepreneurial decision-making (Rong, 2024; Shi et al., 2026). Rather than replacing entrepreneurs, contemporary AI increasingly functions as an augmentation technology that supports human judgement through information retrieval, idea generation, predictive analytics, contextual recommendations and evidence synthesis while preserving human responsibility and strategic control (Shi et al., 2026; Orozova et al., 2024).

Recent advances in generative AI, large language models, machine learning, predictive analytics, recommendation systems, simulation and gamification (Zirek, 2024) have significantly expanded the range of AI applications available throughout the entrepreneurial process. These technologies support activities such as opportunity recognition, business-model development, market analysis, customer validation, risk assessment and entrepreneurial learning (Shi et al., 2026; Zirek, 2024). At the same time, entrepreneurs increasingly require competencies such as AI literacy, data interpretation, systems thinking and the ability to critically evaluate AI-generated outputs (Orozova et al., 2024).

Despite these advances, existing AI applications remain largely task-specific. Most studies focus on individual functions, such as idea generation, mentoring, personalised learning, business analytics, or simulation, rather than supporting entrepreneurial decision-making as a continuous process spanning the entire pre-incubation lifecycle (Chen, 2026; Park, 2025; Qiu, 2024; Zirek, 2024).

Consequently, the literature lacks an integrated framework for AI-supported decision-making throughout the pre-incubation programme.

3 Research Methodology and Results

3.1 Methodology

The aim of this study is to systematically analyse how AI-supported decision-making is addressed in preincubation/entrepreneurship/venture development and HE literature and to design requirements for an AI-supported conceptual framework for decision-making in university pre-incubation programmes.

To achieve this objective, the literature was analysed from three complementary analytical perspectives: functional, process and technology-architectural. Together, these perspectives provided the analytical foundation for deriving the design requirements of the proposed AI-supported decision-making framework.

The study is organized around the following research questions (RQ):

RQ1. Which entrepreneurial decision-making activities are currently supported by AI in entrepreneurship and HE literature?

RQ2. Which stages of entrepreneurial development are most frequently addressed by AI-based approaches?

RQ3.1. What AI approaches are used to support entrepreneurship and decision-making?

RQ3.2. What architectural components are described in existing AI-supported entrepreneurship systems?

In this study, architectural components refer to the conceptual functional building blocks of AI-supported entrepreneurship systems (e.g., AI services, knowledge resources, data sources, end-users applications) that enable decision support.

To answer these questions, a **scoping literature review (ScR)** was conducted using the **Scopus** and **Web of Science** databases. A scoping review was selected because it is particularly suitable for mapping emerging research fields, clarifying conceptual boundaries, identifying research trends and synthesising heterogeneous evidence without restricting the review to a specific study design (Peters et al., 2015). The review focused on publications published between 2024 and 2026 to capture the period of rapid expansion in generative AI research. Following the public release of ChatGPT in late 2022, the literature experienced an exponential increase from 2024 onwards, reflecting the growing adoption of generative AI and large language models in HE (Dai et al., 2026).

The search strategy combined keywords related to **pre-incubation/entrepreneurship/venture development, HE, decision support/decision-making and AI**. The final search query used in Scopus and Web of Science was: query: TITLE-ABS-KEY (("pre-incubation" OR preincubation OR "early-stage venture*" OR "early stage venture*" OR venture* OR entrepreneurship) AND ("decision support" OR "decision support system*" OR DSS OR "decision making" OR "decision-making") AND ("higher education" OR universit* OR college*) AND ("artificial intelligence" OR AI OR "intelligent system*")) AND PUBYEAR > 2023 AND PUBYEAR < 2027

The broader search terms "artificial intelligence" and "AI" were intentionally used to ensure comprehensive retrieval of relevant literature. More specific AI approaches were subsequently identified and analysed during the full-text coding process.

The database search identified **296 records**, including **39 publications from Scopus** and **257 publications from Web of Science**. After removing **7 duplicate records**, **289 papers** remained for title and abstract screening. During the initial screening phase, each paper was assessed based on four predefined screening questions (SQ) - inclusion criteria:

SQ1. Does the study address entrepreneurship or venture development?
SQ2. Does the study address decision making or decision support?
SQ3. Does the study focus on development of entrepreneurial ideas within or connected to higher education institutions?
SQ4. Does the study involve AI?

Each criterion was independently coded as Yes, Partially or No. Only papers receiving Yes for all four inclusion criteria were included in the subsequent full-text review. This screening excluded 269 papers, resulting in 20 studies for qualitative analysis. The study selection process was conducted and reported in accordance with the PRISMA 2020 reporting guidelines (Page et al., 2021). Following the PRISMA workflow, records were identified, screened against the predefined inclusion criteria, assessed for full-text eligibility and finally included in the qualitative synthesis, with the number of retained and excluded records documented at each stage, as illustrated in Fig. 1.

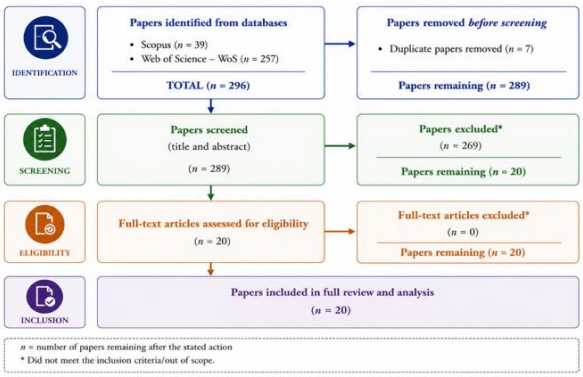


Figure 1. PRISMA Flow Diagram of the Study Selection Process

In the second phase, the **20 selected papers** were analysed in full. Data extraction focused on identifying the characteristics required to answer the research questions. Specifically, each study was coded according to analytical questions (AQ):
AQ1. What stage of entrepreneurship is addressed?
AQ2. Which decision-making domains are addressed?
AQ3.1 Which AI technologies and approaches are used?
AQ3.2 Does the paper describe a system architecture? If yes, which architectural components are mentioned?, and **its contribution to framework development**.

Finally, the extracted evidence was synthesised according to the three analytical perspectives. The resulting findings guided the development of the proposed AI-supported conceptual framework.

3.2 Scoping Literature Review Results

The qualitative analysis of the 20 selected studies identified recurring patterns across the three analytical perspectives defined in this study: functional, process and technology-architectural. In addition to addressing the RQs, each study was examined for complementary design characteristics relevant to the development of an AI-supported decision making in pre-incubation framework, including stakeholder roles, human oversight and governance aspects. **Table 1** summarises the main findings of the scoping review and illustrates how they guided the development of the proposed conceptual framework.

The final corpus consisted of 20 recent studies published between 2024 and 2026: six papers from 2024, seven from 2025 and seven from 2026. All included studies met the four first-phase inclusion criteria by connecting entrepreneurship, startup development or pre-incubation with decision making or decision support, HE and AI. The analysed studies were heterogeneous in scope and design. Some papers presented empirical studies of students, teachers, entrepreneurs or expert perceptions, some proposed conceptual or regulatory frameworks, and others described AI-enabled systems, platforms, simulations or recommendation mechanisms. Substantively, the corpus covered entrepreneurship education, competency development, entrepreneurial readiness, opportunity recognition, idea and business-model development, venture evaluation, risk and feasibility assessment, resource-allocation decisions, responsible AI and evaluator matching. The AI approaches discussed or applied across the corpus included generative AI and LLMs, machine and deep learning, predictive analytics, recommendation systems, knowledge graphs, learning analytics and simulation-based approaches. The diversity of the analysed studies required qualitative coding to systematically identify common patterns across entrepreneurial stages, decision domains, AI approaches and architectural components.

Despite this diversity, a consistent pattern emerged across the analysed studies. Existing research predominantly addresses isolated entrepreneurial activities or task-specific AI applications, whereas AI-supported decision-making across the complete pre-incubation lifecycle has received relatively limited attention. This identified gap represents the principal motivation for the proposed conceptual framework.

3.3 Conceptual Framework for AI-supported Decision-Making in Pre-incubation

The proposed conceptual framework (Fig. 2) was developed by synthesising insights from the background literature and the findings of the scoping review. Rather than directly translating the frequency of individual findings into framework elements, the review findings were conceptually synthesised. Frequently recurring concepts informed the core

framework dimensions, whereas less frequent but conceptually important findings were incorporated into broader functional or architectural components.

The framework was further informed by the authors' research and development experience in entrepreneurship support, learning design, learning analytics, AI-supported educational technologies and digital solutions for higher education.

Together, these inputs shaped the three complementary and interdependent dimensions of the framework: the Process Dimension, defining when entrepreneurial decisions occur; the Functional Dimension, specifying what decisions require support at each stage; and the Technology-Architectural Dimension, determining how AI capabilities, data resources, knowledge resources and end-user applications provide this support. Stakeholder roles and the Human-in-the-loop principle were incorporated as cross-cutting governance mechanisms spanning all three dimensions, ensuring that AI-generated insights are interpreted, validated and translated into final entrepreneurial decisions.

Design principle. AI is designed to augment rather than replace human judgement. Students, teachers, mentors, programme managers, evaluators and industry experts remain responsible for interpreting AI outputs, validating evidence, contextualising recommendations and making final decisions. This principle reflects the educational and entrepreneurial nature of pre-incubation, where AI supports evidence-based decision-making while preserving human responsibility, transparency and ethical oversight (Busch et al., 2025; Kadoić et al., 2026; Yordudom et al., 2026).

Process Dimension. The process dimension integrates the entrepreneurial stages identified across the reviewed studies with the process logic described in the foundational pre-incubation literature. Although the search strategy explicitly included the term pre-incubation, none of the selected studies conceptualised pre-incubation as a distinct AI-supported decision-making process. Instead, the reviewed literature predominantly addresses entrepreneurship education, entrepreneurial readiness, opportunity recognition, idea development, business-model development, validation and early venture development as separate educational or entrepreneurial activities (Park, 2025; Shi et al., 2026; Yordudom et al., 2026; Zirek, 2024).

Functional Dimension. The functional dimension synthesises the entrepreneurial decision domains identified across the reviewed studies. The literature predominantly addresses entrepreneurial readiness, opportunity recognition and evaluation, idea and business-model development, validation and risk- and feasibility-related decisions (Chen, 2026; Park, 2025; Rong, 2024; Sánchez Gonzales et al., 2026; Yordudom et al., 2026; Zirek, 2024). Building on these findings, the framework structures entrepreneurial decision-making into eight interconnected decision domains spanning the pre-incubation lifecycle: readiness assessment, problem framing, opportunity evaluation, idea selection, business-model evaluation, validation decision, pitch evaluation and incubation readiness assessment. Each domain represents a distinct entrepreneurial decision point at which AI supports evidence generation, recommendations, analytics and feedback, while final decisions remain under human responsibility.

Technology-Architectural Dimension. The technology-architectural dimension synthesises the AI technologies and approaches and architectural characteristics identified in the reviewed studies. The literature demonstrates a broad range of AI technologies, including generative AI, large language models, machine learning, deep learning, predictive analytics, recommendation systems, knowledge graphs, learning analytics and simulation-based approaches (Chen, 2026; Park, 2025; Qiu, 2024; Rong, 2024; Wang & Gu., 2026; Zirek, 2024). Based on this synthesis, the Technology-Architectural Dimension comprises four complementary architectural components.

AI-supported decision-support services represent an integrated layer that supports entrepreneurial decision-making throughout the pre-incubation lifecycle. Unlike individual AI applications identified in the reviewed studies (e.g., recommendation systems, tutoring tools or predictive models), these services combine multiple AI capabilities across successive entrepreneurial decision points. They also support the diverse information and decision-support needs of different stakeholder groups, including students, mentors, teachers, evaluators and programme managers. Their value lies in supporting continuity of decision-making rather than optimising isolated tasks. Accordingly, they provide capabilities such as recommendation, prediction, matching, analytics, explanation, summarisation, content generation and simulation.

Knowledge and content resources integrate entrepreneurial knowledge, business models, methods, best practices and case studies required to contextualise AI recommendations. **Data sources** combine educational, entrepreneurial and contextual information, including learning data, student and team profiles, entrepreneurial artefacts, mentor feedback and external ecosystem data.

Table 1. Summary of the ScR findings and their contribution to the proposed conceptual framework

Analytical question	Main findings from the literature review and no of studies	Contribution to the framework
AQ1. What stage of entrepreneurship is addressed?	• entrepreneurship education or competence (17) • opportunity recognition (6) • idea development (5) • early-stage venture development or business planning (19)	Defines the **Process Layer** by identifying stages that should be supported within pre-incubation lifecycle.
AQ2. Which decision-making domains are addressed?	• education or competencies decisions (16) • readiness decisions (8) • risk or feasibility decisions (10) • resource-allocation decisions (6) • governance decisions (7) • responsible-AI decisions (6) • evaluator-matching decisions (1) • opportunity, idea or business-model decisions (8)	Defines the **Functional Layer** by identifying the key entrepreneurial decision domains that should be supported throughout the pre-incubation process.
AQ3.1 Which AI technologies and approaches are used?	• generative AI and LLMs (10 studies) • machine/deep learning (11) • predictive analytics (9) • recommendation systems (4) • knowledge graphs (3) • learning analytics (4)	Defines the **Technology-Architectural Layer** by identifying the AI services and architectural components required to support an AI-supported decision-making framework for university pre-incubation programmes.
AQ3.2 Does the paper describe a system architecture? If yes, which architectural components are mentioned?	• explicit architectures (7) • partial/workflow architectures (5) • no technical architecture (4) Recurrent components: user applications/dashboards; role-specific interfaces; data sources; LMS, student/team and project data; knowledge/content repositories; recommendation engines; learning analytics; predictive models; simulation tools; feedback/evaluation mechanisms.	

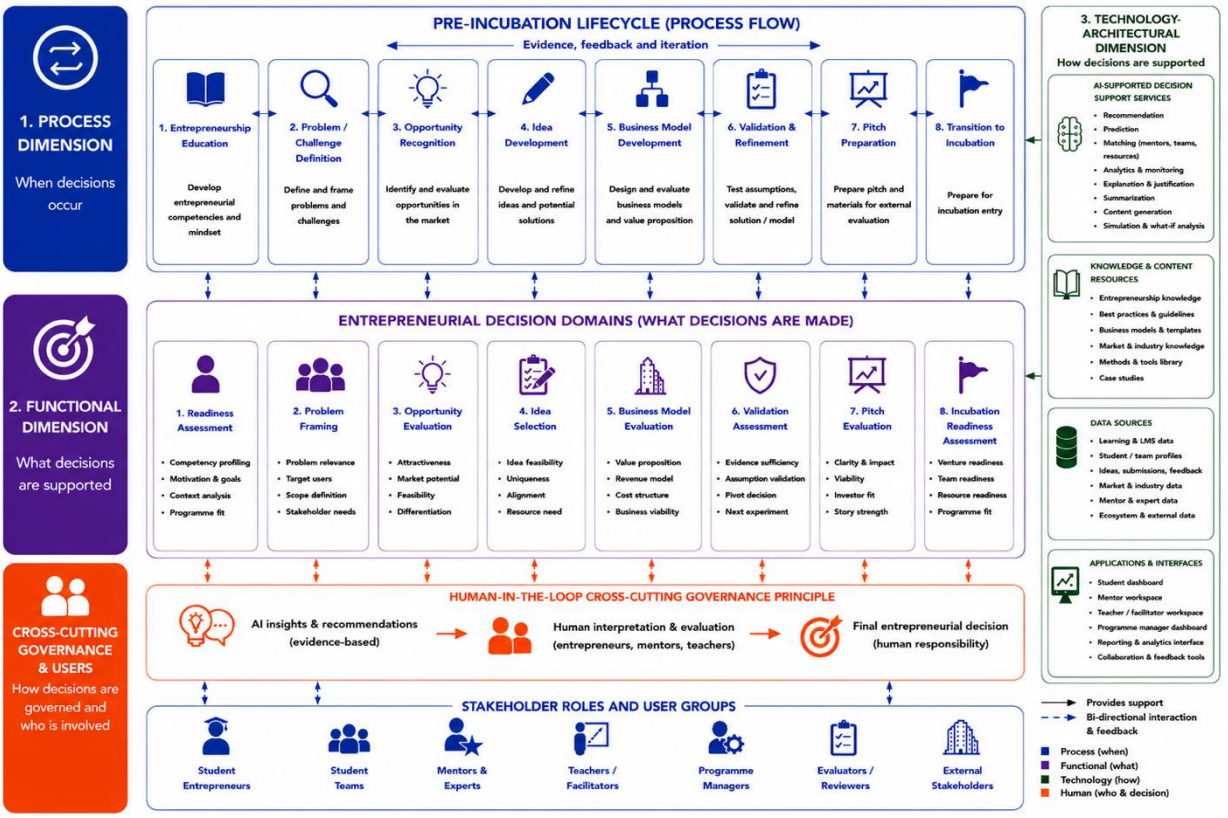


Figure 2. A three-dimensional framework for AI-Supported Decision-Making in Pre-Incubation Programmes

Finally, **applications and interfaces** deliver these capabilities to different stakeholder groups through role-specific dashboards and collaborative workspaces. Together, these components form a technology-agnostic architecture that supports entrepreneurial decision-making throughout the pre-incubation process.

User applications are reflected in student interfaces, dashboards, intelligent tutoring systems, Q&A tools, feedback mechanisms and recommendation environments (Chen, 2026; Wang & Gu, 2026; Park, 2025; Qiu, 2024).

Data sources include LMS data, student profiles, learning behaviour, project data, venture submissions, market information and evaluator or mentor data. Knowledge and content resources are represented through course materials, entrepreneurial cases, knowledge graphs, business-model templates and institutional knowledge bases (Shi et al., 2026; Chen, 2026; Wang & Gu, 2026; Xi et al., 2025; Qiu, 2024; Zirek, 2024).

User and Stakeholder Layer. The reviewed studies indicate that AI-supported entrepreneurial environments involve multiple stakeholder groups with different goals, responsibilities and information needs, including student entrepreneurs, teams, mentors, teachers, evaluators, programme managers and external ecosystem partners (Chen, 2026; Mele et al., 2022; Qiu, 2024; Wang et al., 2026; Xi et al., 2025; Zirek, 2024). Accordingly, the framework provides role-specific applications and interfaces tailored to the decision-support needs of each stakeholder group.

Human-in-the-loop as Cross-cutting Governance Principle. The reviewed studies consistently position AI as a decision-support technology that augments rather than replaces human judgement. While AI provides recommendations, predictions, analytics, matching, personalised feedback and early intervention signals, human stakeholders remain responsible for interpreting AI outputs, validating evidence, contextualising recommendations and making final decisions. This reflects the growing emphasis on transparency, ethical AI use, privacy, bias mitigation and human oversight in AI-supported entrepreneurship and education (Busch et al., 2025; Vargas, 2024; Romero-Untiveros & Melgarejo-Solis, 2024; Orozova et al., 2024; Chen, 2026; Wang & Gu, 2026; Xi et al., 2025).

4 Conclusion and Future Work

This study addressed the growing need for AI-supported decision-making in university pre-incubation programmes through a scoping literature review of recent research at the intersection of entrepreneurship, HE, decision support and AI. The review demonstrated that existing studies predominantly focus on isolated AI applications, educational support or individual entrepreneurial activities, while AI-supported decision-making throughout the pre-incubation process remains largely unexplored.

The review provides four main findings. First (RQ1)**,** the literature predominantly addresses the earliest stages of entrepreneurship, particularly entrepreneurship education, opportunity recognition, idea development and validation, while providing limited support for later stages of the pre-incubation lifecycle.

Second (RQ2)**,** AI is primarily applied to support entrepreneurial decision domains related to educational guidance, entrepreneurial readiness, opportunity recognition, idea development, business-model evaluation, validation and risk or feasibility assessment. Third (RQ3.1)**,** a broad range of complementary AI technologies and approaches has been adopted, including generative AI, large language models, machine learning, predictive analytics, recommendation systems, knowledge graphs, learning analytics and simulation. Finally (RQ3.2)**,** although several studies describe individual AI systems or partial architectures, comprehensive AI-supported architectures for university pre-incubation programmes remain largely absent.

Collectively, these findings provide the foundation for the proposed three-dimensional conceptual framework, which integrates the entrepreneurial process, entrepreneurial decision domains and technology-architectural capabilities into a unified model for university pre-incubation programmes. In addition to these three complementary dimensions, the framework incorporates stakeholder roles/user groups and the human-in-the-loop principle as cross-cutting elements spanning all dimensions, ensuring that AI augments rather than replaces human judgement.

From a theoretical perspective, the framework contributes to entrepreneurship and AI research by integrating concepts from entrepreneurial development, decision-making, AI-supported decision support and educational technologies into a coherent conceptual architecture. It extends current discussions by conceptualising pre-incubation as a continuous AI-supported entrepreneurial decision-making process rather than a collection of isolated AI applications.

From a practical perspective, the framework provides design guidance for universities, entrepreneurship educators, programme managers, mentors and system developers interested in developing AI-supported pre-incubation platforms based on the proposed framework. It identifies the key entrepreneurial decision domains, AI capabilities, data and knowledge resources, stakeholder roles and governance principles that should be considered when designing future AI-supported entrepreneurial ecosystems.

Although AI has considerable potential to support entrepreneurial decision-making, its practical implementation also introduces several challenges. The quality and reliability of AI recommendations

depend on the availability of accurate, complete and contextually relevant data, while biased or incomplete information may affect the quality of generated outputs. Furthermore, excessive reliance on AI recommendations may reduce critical reflection or entrepreneurial autonomy if recommendations are accepted without appropriate human evaluation. Consequently, AI-supported pre-incubation environments require appropriate governance mechanisms addressing data quality, transparency, ethical use, accountability and continuous human oversight to ensure that AI augments rather than replaces entrepreneurial judgement.

The study has two main limitations. First, the review was restricted to publications indexed in Scopus and Web of Science published between 2024 and 2026.

Second, the proposed framework represents a conceptual design derived from literature synthesis and the authors' research experience. Consequently, its usefulness and completeness have not yet been validated in authentic university pre-incubation settings.

Future work will therefore focus on implementing the framework within a real pre-incubation programme and evaluating its usefulness, usability and educational impact through studies.

Further studies should also examine how AI can provide context-aware, explainable and personalised decision support throughout the entrepreneurial idea development process.

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