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## ARTIFICIAL INTELLIGENCE AND SUSTAINABLE ENTREPRENEURSHIP NEXUS: A REVIEW

**Dong Li <sup>1\*</sup>, Guoxi Xue <sup>2</sup>, Shaowei Miao <sup>3</sup>, Xinyue Qiao <sup>4</sup>, Valentine Kirimi Muriira <sup>5</sup>**

<sup>1\*,3</sup> *Zhongyuan Institute of Science and Technology, Zhengzhou, 451400, Henan, China*

<sup>1\*,2,3,5</sup> *INTI International University, Persiaran Perdana BBN Putra Nilai, 71800 Nilai, Negeri Sembilan, Malaysia*

<sup>2</sup> *ABa Teachers College, Wenchuan, 623002, Sichuan, China*

<sup>4</sup> *College of Landscape Architecture and Art, Henan Agricultural University, Zhengzhou 450002, China*

E-mail: <sup>1\*</sup> [lidong920108@163.com](mailto:lidong920108@163.com) (Corresponding author)

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**Abstract.** This paper provides a bibliometric review of sustainable entrepreneurial intention in relation to artificial intelligence (AI). Based on a dataset of 1,855 peer-reviewed articles indexed in Scopus between 2015 and 2025, the paper makes use of co-citation analysis, keyword mapping, and trend evolution to analyse the evolution and frontiers of the field. There are four major themes: (1) AI-augmented entrepreneurial cognition, covering AI's relationship to ideation and innovation; (2) sustainability-driven motivation, focusing on environmental values and behavioural drivers influencing sustainable entrepreneurial intention; (3) entrepreneurship education; (4) ethical trust and legitimacy, addressing transparency and governance of AI applications. The results show that AI functions as a technological and cognitive facilitator, affecting the formation of entrepreneurial intentions and shaping pedagogical practices. This study not only contributes theoretically but also offers practical recommendations for educators, policymakers, and technology developers seeking to foster sustainable, ethical, and AI-based entrepreneurial ecosystems.

**Keywords:** Artificial Intelligence; Sustainable Entrepreneurship; Sustainable Entrepreneurial Intention; Bibliometric Review; Entrepreneurship Education; AI Ethics

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### 1. Introduction

In the wake of accelerating ecological crises and technological disruption, the intersection of sustainable entrepreneurial intention (SEI) and artificial intelligence (AI) has emerged as a rapidly expanding research frontier (Appio et al., 2024). As entrepreneurs seek to reconcile economic ambition with environmental and social imperatives, AI is increasingly viewed not only as a technological enabler but also as a cognitive augmentation tool that transforms the entrepreneurial decision-making process (Bickley et al., 2025; Mohammed et al., 2025).

Recent scholarship underscores the dual role of AI in enhancing data-driven opportunity recognition and influencing entrepreneurial motivation through cognitive support systems (Giuggioli & Pellegrini, 2022). Studies highlight AI's contributions to sustainability-oriented business models, green innovation, and the evolution of entrepreneurial education (Ahmić & Šahović, 2025; Asad et al., 2025). However, despite a surge in research activity, the field remains conceptually fragmented and methodologically disjointed (Abushanab, 2024). Specifically, little is known about how AI reshapes the intentionality, value orientation, and trust dynamics underpinning SEI, particularly from a cross-disciplinary perspective (Gupta et al., 2023).

Sustainable entrepreneurship (SE) involves business activities that create economic, environmental, and social value at the same time. Sustainable entrepreneurial intention (SEI) reflects an individual's motivation and willingness to take part in such activities in the future. SEI is often seen as a first step toward SE. In line with the Theory of Planned Behaviour, it represents the translation of sustainability-related values, social expectations, and perceived control into the decision to start or adapt a business toward sustainable goals. Studies show that values and future orientation influence SEI, which then leads to sustainable entrepreneurial actions (Thelken & de Jong, 2020). SEI has also been linked to attitudes and perceived behavioural control as strong predictors of action (Peng et al., 2021). In addition, evidence suggests that entrepreneurial intention can predict sustainable business behaviour, while risk perception plays a mediating role (Yang et al., 2022). Focusing on SEI helps explain how AI-supported tools may shape sustainability-oriented entrepreneurial thinking before real business action takes place.

While prior bibliometric studies have separately explored AI-driven entrepreneurship and sustainability-focused innovation, few have systematically mapped the knowledge structure, thematic evolution, and intellectual influence at the convergence of SEI and AI (Wadhwa & Bansal, 2024). The absence of integrative frameworks limits our understanding of how AI technologies affect the formation of sustainable entrepreneurial intentions across contexts. To address these gaps, the primary objectives of this study are: (1) To map the thematic evolution, co-citation structures, and keyword co-occurrence networks in the SEI and AI literature; (2) To identify key intellectual contributors, institutional collaborations, and publication trends; (3) To uncover emerging research hotspots and theoretical opportunities. Guided by these objectives, this study addresses the following research questions:

1. What are the prevailing research trends and thematic clusters at the intersection of SEI and AI?
2. Who are the most influential authors, institutions, and journals shaping this domain?
3. What research gaps and conceptual frontiers can be identified through bibliometric mapping?

By clarifying the intellectual architecture and developmental trajectory of SEI and AI research, this research provides a foundation for future interdisciplinary inquiry. The findings offer insights for scholars, educators, policymakers, and technologists aiming to foster responsible, AI-empowered, and sustainability-oriented entrepreneurial ecosystems.

The remainder of the article is structured as follows: Section 2 presents the theoretical background and critically analyses the background scholarship at the confluence of sustainable entrepreneurial intentions and artificial intelligence, with a view to highlighting still-existing conceptual or methodological deficiencies. Section 3 describes the research design, including the data-gathering strategy, bibliometric procedures, and analysis approaches used to identify the intellectual and thematic organisation of the field. Section 4 presents and analyses the empirical findings, including trend analyses, co-citation networks, and keyword co-occurrence patterns, to reveal prevailing and emerging research themes. Section 5 discusses the theoretical implications as well as practical implications for academia, policy, and technology development. Finally, Section 6 provides the conclusion, addresses the study's limitations, and outlines a future research agenda for cross-disciplinary research.

## 2. Literature Review

### 2.1 Theoretical Foundations of Sustainable Entrepreneurial Intentions (SEI)

Sustainable entrepreneurial intentions (SEI) refer to an individual's conscious and future-oriented commitment to launch ventures that pursue not only economic returns but also social and environmental value. Grounded in the Theory of Planned Behaviour (TPB), SEI has been theorised as a multidimensional construct encompassing ecological concern, ethical obligation, and perceived behavioural control (Peng et al., 2021). Compared to general entrepreneurial intention, SEI places greater emphasis on pro-social motivations and environmental sustainability as core behavioural drivers.

In the last ten years, the literature has moved beyond cognitive antecedents centred on self-efficacy and personal attitudes and has started shifting toward more systemic, stakeholder-involved perspectives (Anser et al., 2024). Recent research highlights the roles of ecological mindsets, social norms, and sustainability narratives in shaping SEI. This transformation reflects broader socio-environmental changes and calls for entrepreneurs to serve as agents of sustainable development. The education sector is another key driving force behind sustainability-oriented entrepreneurship, as universities increasingly incorporate sustainability values into entrepreneurial education (Lopez-Leyva et al., 2022). The blended method of teaching, involving the combination of innovation, behavioural science, and environmental ethics, has proved its effectiveness in the development of sustainable intentions among the students. In the higher education sector, the augmentation of simulations and experience-based learning models with AI, in turn, complements SEI through aligning the inspirations of the students with green innovativeness (Juanda et al., 2024).

However, the knowledge base remains fragmented. Some research streams emphasise affective and motivational factors, while others focus on institutional and policy-level determinants (Goel et al., 2024). These silos lack integrative modelling and often ignore longitudinal dynamics in intention development. In conclusion, SEI research has diversified in scope and theoretical grounding, yet still requires deeper conceptual coherence, particularly regarding technology-mediated intention formation.

## 2.2 Artificial Intelligence as a Cognitive and Strategic Enabler of SEI

Artificial intelligence is increasingly recognised as a transformative force in entrepreneurship, enabling data-driven forecasting, resource efficiency, and low-carbon innovation (Jose & Muhammed, 2024). Entrepreneurs are using AI tools to anticipate market dynamics, design eco-conscious products, and streamline decision-making, thereby aligning business goals with sustainability objectives.

At the cognitive level, AI has been shown to enhance opportunity recognition, reduce uncertainty, and simulate complex entrepreneurial scenarios (Usman et al., 2024). Generative AI systems such as ChatGPT are now framed as cognitive companions that support entrepreneurial ideation, reflection, and self-efficacy. The intention formation literature discusses methods to facilitate cognition processes in the making of decisions. Modern interventions often employ real-time feedback systems that minimise cognitive load in complex decision scenarios (Sarumi, 2024).

Recent studies note that top-down mechanisms, such as green leadership and institutional AI policies, are central to leveraging AI for sustainable innovation (Zhao & Gómez, 2023). However, there are also still significant barriers, particularly for smaller and medium-sized businesses (SMEs), such as insufficient technical capacity, a lack of explainability, data bias persistence, and the general accountable implementation of AI. Due to such ethical constraints, the realisation of the sustainable, innovative, and human-AI interaction principles requires governance frameworks that integrate these three principles.

Recent literature suggests that the perceived moral integrity of AI is beginning to shape entrepreneurial intention. Empirical evidence shows that entrepreneurs are more likely to adopt AI into their sustainable enterprises when they trust the tool's fairness, transparency, and accountability (Klarin et al., 2024). This marks a shift from viewing AI as a value-neutral tool to perceiving it as a socially situated agent in the development of entrepreneurial motivation. Consequently, AI is transforming sustainable entrepreneurial innovation not only by enhancing capabilities but also by introducing new ethical, psychological, and institutional dimensions to the entrepreneurial process.

## 2.3 Bridging SEI and AI: Insights from Bibliometric Research and Research Gaps

In the recent bibliometric studies, the emerging intersection of entrepreneurship and AI is characterised as a growing focal point currently active in the field, and research in this intersection covers exploration of the field of business models based on AI, digital transformation, and innovation with sustainability (Wadhwa & Bansal, 2024). Co-citation, keyword co-occurrence, and bibliographic coupling methods have been used to trace thematic clusters and intellectual foundations in this emerging field (Goel et al., 2024).

Despite this growth, most bibliometric analyses treat AI, entrepreneurship, and sustainability as parallel rather than integrated streams (Dasawat & Sharma, 2023). As a result, critical questions remain unanswered: How do AI technologies alter the cognitive pathways of SEI? What ethical tensions arise when AI mediates sustainable entrepreneurial intent? Which collaborative networks and institutions are shaping this new interdisciplinary domain?

The literature also reveals under-theorised constructs such as digital sustainability, namely the idea that AI should not only improve efficiency but also contribute to systemic transformation aligned with the UN SDGs (Yang & Lee, 2024). Few studies explore how AI amplifies or constrains sustainability salience, particularly in emerging economies where digital infrastructure is uneven.

Theoretical integration is urgently needed. Existing models like TPB, stakeholder theory, and institutional logic fail to account for AI's dynamic, context-sensitive role. Scholars have called for new frameworks such as the AI-PEN (Prospecting and Establishing Nexus) model and human–AI collaboration theory to map these evolving patterns (Giuggioli & Pellegrini, 2022). These models can potentially bridge intention, cognition, ethics, and technology into a unified framework. In conclusion, the bibliometric landscape confirms a growing scholarly interest in SEI and AI convergence but highlights a lack of theoretical integration and contextual nuance, a gap this study seeks to address.

### 3. Methodology

#### 3.1 Research Design

This study employs a bibliometric analysis to map the intellectual landscape and thematic evolution at the intersection of sustainable entrepreneurial intentions (SEI) and artificial intelligence (AI). Bibliometric techniques offer a systematic and replicable approach to evaluate scholarly output, detect influential contributions, and uncover emerging research trends in complex and interdisciplinary fields.

To this end, we adopted two complementary analytical methods: (1) co-citation analysis, which identifies the intellectual structure of the field by examining documents frequently cited together; (2) keyword co-occurrence analysis, which reveals the conceptual structure by detecting co-appearing terms and thematic clusters. The studies identified in this paper were analysed using VOSviewer, a software application that transforms bibliometric data into visual networks, enabling empirical analysis of intellectual convergence and ideological change.

In analysing the academic discourse of AI-powered sustainable entrepreneurship, we rely on bibliometric network maps and clusters obtained on the basis of VOSviewer-created citation networks. VOSviewer enables the creation of co-authorship, co-citation, and co-occurrence networks and makes them available in the form of a graphical illustration, which can be compared over temporal or disciplinary regions. This type of visualisation will allow a more empirical exploration of the transdisciplinary composition of such fields and will explain where existing studies could be directed better (Orduña-Malea & Costas, 2021; Ding & Yang, 2022).

#### 3.2 Data Collection

The research uses Scopus as the primary data source because the database provides a broad collection of peer-reviewed literature encompassing entrepreneurship, artificial intelligence, and sustainability. Scopus is a credible indexing service with extensive bibliographic records, making it well-suited for large-scale bibliometric research (Baas et al., 2020). Combining journal articles, conference proceedings, and a variety of scholarly articles, Scopus becomes a valid tool in following intellectual turnover and forming themes in a cross-disciplinary scope, specifically artificial intelligence and sustainable entrepreneurship.

To ensure the inclusion of high-quality and relevant publications, we developed a structured search strategy. Through an iterative process, we identified relevant keywords spanning entrepreneurship or innovation, artificial intelligence, and sustainability, and formulated the following query:

**TITLE-ABS-KEY** ("entrepreneurial intention" OR "entrepreneurship" OR "innovation") AND **TITLE-ABS-KEY** ("artificial intelligence" OR "AI" OR "machine learning" OR "deep learning" OR "big data") AND **TITLE-ABS-KEY** ("sustainability" OR "green" OR "eco-friendly" OR "green economy" OR "environmental sustainability" OR "CSR" OR "corporate responsibility") AND **PUBYEAR** > 2004 AND **PUBYEAR** < 2026 AND (**LIMIT-TO**(DOCTYPE, "ar") AND (**LIMIT-TO**(LANGUAGE, "English") AND (**LIMIT-TO**(SRCTYPE, "j") AND (**LIMIT-TO**(PUBSTAGE, "final").

The initial search yielded 4,968 documents. After narrowing the parameters to publication years between 2015 and 2025 and limiting the dataset to peer-reviewed journal articles in the English language that were finalised for publication, the dataset consisted of 1,855 articles, as shown in Table 1.

**Table 1.** Data Collection Process and Search Strategy in Scopus Summary

| Step                                | Description                    | Details / Parameters                                                                                                                                                                                                                                                                                                                                                               | Outcome                                                                          |
|-------------------------------------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| <b>1. Data Source Selection</b>     | Primary database chosen        | Scopus covers peer-reviewed scholarly materials in entrepreneurship, AI, and sustainability; it is a credible indexing service with extensive bibliographic records (Baas et al., 2020)                                                                                                                                                                                            | Suitable for large-scale bibliometric research                                   |
| <b>2. Rationale</b>                 | Reason for selection           | Cross-disciplinary coverage (entrepreneurship, AI, sustainability); includes journal articles, conference proceedings; supports tracking intellectual turnover and theme formation.                                                                                                                                                                                                | Valid for AI & sustainable entrepreneurship research                             |
| <b>3. Search String Development</b> | Keywords and Boolean operators | <b>TITLE-ABS-KEY</b> ("entrepreneurial intention*" OR "entrepreneurship" OR "innovation") AND <b>TITLE-ABS-KEY</b> ("artificial intelligence" OR "AI" OR "machine learning" OR "deep learning" OR "big data") AND <b>TITLE-ABS-KEY</b> ("sustainability" OR "green" OR "eco-friendly" OR "green economy" OR "environmental sustainability" OR "CSR" OR "corporate responsibility") | Captures entrepreneurship/innovation, AI technologies, and sustainability topics |
| <b>4. Initial Query Parameters</b>  | Additional filters             | <b>PUBYEAR</b> > 2004 AND <b>PUBYEAR</b> < 2026; document type: "ar"; language: English; source type: journal; publication stage: final                                                                                                                                                                                                                                            | <b>Initial results:</b> 4,968 documents                                          |
| <b>5. Refinement Criteria</b>       | Narrowing search               | Publication years: 2015–2025; peer-reviewed journal articles; English language; finalized publications only                                                                                                                                                                                                                                                                        | <b>Final dataset:</b> 1,855 articles                                             |

*Note:* Retrieved the data in Scopus; search done using the given Boolean search with filtering on year, language, document type, and publication stage.

### 3.3 Data Analysis

The current analysis relies on VOSviewer 1.6.20, a software program for constructing and querying bibliometric networks. Based on a mixture of citation data, co-occurring keywords, and co-citation, the software creates a detailed but informative visualisation of a disciplinary landscape (Kartal & Yeşilyurt, 2024). Two primary forms of analysis were employed in the study: co-citation analysis and keyword co-occurrence analysis.

Co-citation analysis helped to identify highly influential publications by capturing documents that are frequently cited together. The co-cited papers identify citation pairs, which may suggest shared theoretical underpinnings or methodological approaches. They are therefore valuable for revealing the major intellectual clusters in the domain of AI and sustainable entrepreneurship research. Co-citation analysis also displays the predominant papers, authors, and sources that shape and continue to shape an academic discourse over time (Thayyib et al., 2023). In contrast, keyword co-occurrence analysis maps thematic linkages by identifying keywords that co-occur in the same documents. The keyword co-occurrence analysis enables the identification of emerging topics, prevalent themes, and interdisciplinary links that occur throughout the dataset as a whole.

To capture the temporal dynamics of research evolution, we employed overlay visualisation techniques. These highlight the chronological emergence of themes, showing how scholarly attention has shifted from general sustainability concepts to more nuanced topics such as responsible AI governance, AI-augmented intention models, and ethics-oriented entrepreneurship education. All bibliometric indicators, such as citation counts, link strength, and cluster density, were analysed to interpret the structural and thematic composition of the field.

Together, these analyses provide a multidimensional portrayal of how AI and SEI research domains are converging, offering both retrospective insights and forward-looking trajectories.

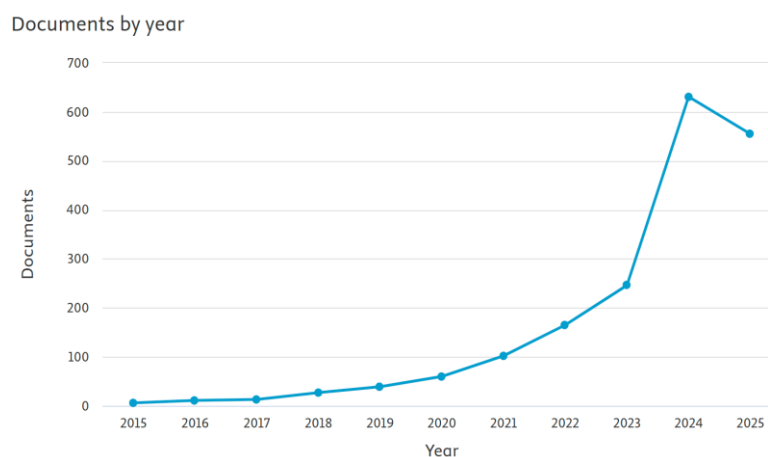
## 4. Results and Discussion

### 4.1 Trend Analysis

Figure 1 illustrates the yearly publication distribution of sustainable entrepreneurship, artificial intelligence (AI), and innovation. The trend indicates a growing academic interest in this multidisciplinary field, particularly since 2020. From 2015 to 2018, the annual publication count fluctuated below 50 documents. The low output confirms that scholarship in AI-powered sustainable entrepreneurship was in its infancy. In 2019, an incremental upward rise began. The annual count of relevant publications began to rise in tandem with the overall proliferation of AI and the increasing emphasis on sustainability-based innovation. The years 2020 and 2021 saw a substantial increase, with document count nearly doubling. As a result, scholars began to acknowledge the role of AI technology in transforming entrepreneurial ecosystems toward sustainability.

The most significant acceleration occurred between 2022 and 2023. In 2022, roughly 230 articles were published. With a meteoric rise in 2023, over 600 publications were produced, the highest figure in the entire dataset. This surge was occurring alongside increasing global attention to digital sustainability, climate entrepreneurship, and the responsible integration of AI into business models. Scholars have begun to explore how knowledge and intelligent systems can maximise the sustainable purpose of business operations, inform sustainable startup businesses, and align entrepreneurial behaviour with the UN Sustainable Development Goals (SDGs) (Bickley et al., 2025).

The evidence suggests a slight decrease anticipated in 2025; this is likely a consequence of the data collection cutoff in May 2025, rather than a sample of diminished academic interest. Additionally, the complete year was not captured in the data collection, and the appearance should be taken as transitory, not an indication of falling interest among scholars. In conclusion, the trend analysis suggests that AI-powered sustainable entrepreneurship has rapidly evolved into a legitimate and expanding area of research. The increasingly abundant publication profile over the years reflects growing global concerns about ecological responsibility, technology disruption, and precise innovation. The scholarly presence is expected to continue expanding in the coming years, alongside the further integration of AI into green business practices and the rise of purpose-oriented entrepreneurship.



**Figure 1.** Number of publications and citations between 2015 and 2025.

Source: Scopus

### 4.2 Citation Analysis

We utilised co-citation analysis to explore the intellectual foundation of sustainable entrepreneurial intentions (SEI) in the context of artificial intelligence (AI), mapping the structural evolution of the academic literature and identifying important works on sustainable entrepreneurship. Co-citation analysis is particularly suitable

for emerging interdisciplinary fields, such as SEI and AI, as it systematically reveals the underlying knowledge base, key themes, and academic convergence patterns (Ferreira & Ferreira, 2024).

The Scopus database was selected as the data source due to its extensive coverage of high-impact journals, rigorous curation, and suitability for advanced co-citation clustering using tools like VOSviewer and Biblioshiny (Manoharan et al., 2024). Of 11,959 cited references, 57 exceeded the citation threshold of 9, forming four major knowledge clusters. To identify the most influential intellectual anchors within the co-citation landscape, the top 10 references with the highest total link strength are summarised in Table 2. These clusters reflect the theoretical scaffolding of SEI research, spanning strategic sustainability, entrepreneurial psychology, AI policy frameworks, and methodological foundations. Figure 2 presents the thematic co-citation network generated using VOSviewer. It visually illustrates the four major intellectual clusters that emerged from the 57 high-frequency co-cited references.

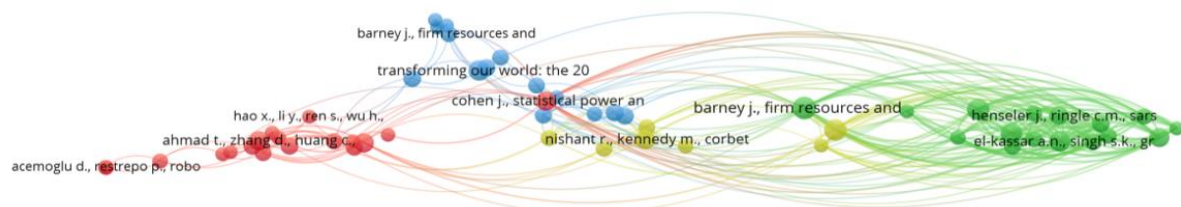
**Table 2.** Top 10 Cited References by Total Link Strength

| Cited Reference                                                                                      | Citations | Total Link Strength |
|------------------------------------------------------------------------------------------------------|-----------|---------------------|
| (European Commission. Directorate General for Communications Networks, Content and Technology, 2021) | 14        | 532                 |
| (Act, 2020)                                                                                          | 38        | 532                 |
| (El-Kassar & Singh, 2019)                                                                            | 18        | 87                  |
| (Fornell & Larcker, 1981)                                                                            | 20        | 82                  |
| (Waqas et al., 2021)                                                                                 | 13        | 82                  |
| (Bag et al., 2020)                                                                                   | 16        | 78                  |
| (Al-Khatib, 2022)                                                                                    | 12        | 75                  |
| (Hair et al., 2019)                                                                                  | 18        | 72                  |
| (Hart, 1995)                                                                                         | 14        | 65                  |
| (Barney, 1991)                                                                                       | 23        | 64                  |

*Note.* Scopus data (2015–2025); total link strength determines the level of co-citation connectivity between a given reference and others within the network, calculated by using VOSviewer.

#### *Cluster 1. Strategic Sustainability and Entrepreneurial Innovation*

This cluster highlights the intersection between sustainable business strategies and entrepreneurial innovation, particularly in AI-driven contexts. Research in this group emphasises the integration of sustainability goals into business models, with green innovation, dynamic capabilities, and triple-bottom-line performance as recurring themes (Anand et al., 2021; Islam & Can, 2024). These studies collectively show that sustainability is increasingly operationalised as a strategic resource that reinforces entrepreneurial competitiveness, rather than a passive compliance mechanism. In addition, recent efforts indicate that the use of analytics facilitated by AI enables companies to have a more predictive understanding of their environmental effects, align their product development with concepts of the circular economy, and detect new markets that can be approached with offers of sustainable products and services (Anand et al., 2021). Such an association of predictive intelligence and eco-innovation has a proactive tendency, as sustainability is incorporated into many decision-making steps in ideation to commercialisation, it will improve resilience and market differentiation (Islam & Can, 2024).



**Figure 2.** Thematic Co-citation Network of AI and Sustainable Entrepreneurship (VOSviewer)

#### *Cluster 2. Entrepreneurial Psychology and Intentional Behaviour*

This cluster includes psychological and behavioural theories that explain how individuals form sustainable entrepreneurial intentions. The existing frameworks include the Theory of Planned Behaviour, entrepreneurial cognition, and digital self-efficacy; however, the more recent additions include algorithmic trust, AI ethics, and moral identity (Blanco-González-Tejero et al., 2023; Rahman et al., 2024), and this demonstrates an overall transition from general models of intention theories to a more digitally embedded psychological framework.

More specifically, the empirical evidence refers to the moderating effect of AI-supported feedback systems, like the customised personalised learning services and real-time environmental data analysis dashboards, on increasing both self-efficacy and commitment to sustainable entrepreneurship (Blanco-González-Tejero et al., 2023). These tools contribute to bridging the intention-behaviour gap through unending reinforcement and performance monitoring that motivates an actor to continue with the effort of exploring eco-innovative ventures despite any uncertainty (Rahman et al., 2024).

#### *Cluster 3. Institutional Frameworks and AI Governance*

This cluster is concerned with macro-influences, such as institutional policies and intermediary regulations that enable sustainable entrepreneurship (SE) as they relate to rest-of-world policies, digital infrastructure policies, and practices. Some of the prominent literature looks at frameworks, including the European Union Digital Finance Strategy and innovation ecosystems aligned with the UN SDGs (Kharchuk et al., 2024; Miah et al., 2024). These studies argue that institutional legitimacy and 'digital readiness' are important precursors to SEI development.

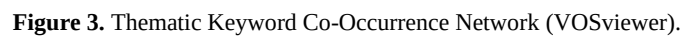
Moreover, international comparisons show that countries such as Denmark and Germany, with the coordinated AI regulation incorporating ethics, transparency criteria, and sustainability incentives, have more chances to scale the green-tech startups fast (Kharchuk et al., 2024; Miah et al., 2024). This synergy between explicit regulatory signals and the possibility to monitor compliance with them with the help of AI technologies decreases barriers to entry, induces confidence in investors, and enables a faster speed of diffusion of sustainable innovations across national boundaries.

#### *Cluster 4. Methodological Rigour and Bibliometric Tools*

The cluster showcases some advancements in methods used in SEI studies, such as the use of VOSviewer and Biblioshiny, bibliometric platforms that allow researchers to visualise and map out knowledge structures. The publications went even further by following standardisation on writing, stating validity, reproducibility, and ultimately mapping precisely what is being done through network-based visual analytics (Kaushik & Dangwal, 2025; Perwitasari et al., 2023). In general, if applications of these types of studies become more widespread, the academic field can build an empirical base and gain further legitimacy as a study area. Also, parallel to the above, scholars are employing the methods of natural language processing (NLP), aiming to integrate and connect bibliometric methods and AI-based topic models to discover emergent trends and identify hidden research themes. This analytical convergence is superior as it facilitates an examination of existing gaps between concepts and disciplines, identification of the frameworks of cross-disciplinary bridges, and strengths in search areas in a given field of sustainable entrepreneurship motivated by AI (El-Kassar & Singh, 2019).

### **4.3 Keyword Analysis**

To investigate the thematic structure, conceptual framework, and intellectual subdomains of sustainable entrepreneurial intentions within the context of artificial intelligence, the study used keyword co-occurrence analysis. Based on 62 high-frequency keywords (occurrence threshold  $\geq 36$ ), four distinct clusters were identified (see Figure 3).



### Cluster 1. AI-Enhanced Entrepreneurial Intentions and Innovation Systems

AI is widely recognised as more than a tool but a cognitive partner within the entrepreneurial process, enabling real-time feedback, opportunity confirmation, and decision-making amid uncertainty (Townsend & Hunt, 2019). By framing generative AI tools such as ChatGPT and GPT-5 as cognitive companions, novice

entrepreneurs can not only alleviate cognitive overload but also reinvigorate their opportunity recognition, business model ideation, and innovation strategies. Their potential as cognitive companions means that their capacity to inform a multitude of decisions, particularly during the uncertainty of striving to be an entrepreneur, is undoubtedly promising (Cimino et al., 2024; Gupta & Yang, 2024).

This cluster suggests a shift in paradigm not only in how we think about entrepreneurial intention but also in how entrepreneurial cognition has traditionally been framed, which originated in individual intention shaped by background traits, and how this intention has transformed into an opportunity evaluation mediated by technology and digitally enhanced cognition.

#### *Cluster 2. Sustainability Values, Motivation, and Psychological Mechanisms*

Cluster 2 (21 items) examines the motivational, attitudinal, and psychological bases of sustainable entrepreneurship, emphasising the influence of pro-environmental values, sustainability orientation, and perceived behavioural control on entrepreneurial intent. Terminology emphasised in this cluster includes sustainability, motivation, behaviour, entrepreneurship education, and the theory of planned behaviour.

Numerous studies have established that a person's values and sense of moral obligation towards the environment are among the most robust antecedents to entrepreneurial intention with youth, especially university students (Kazmi et al., 2019; Baber, 2024; Zhang et al., 2024). The research has shown that youth motivation for green entrepreneurship is heightened when contextualised in an ecological framework or mindset and communicated effectively via digital technologies with sustainability narratives (Uvarova et al., 2021). This cluster affirmed the role of personal agency and moral cognition in social entrepreneurship, which is typically involved in sustainable entrepreneurship, and was digitally supported through AI-aided learning environments and teaching.

#### *Cluster 3. Entrepreneurial Education, Learning Systems, and Youth Engagement*

Cluster 3 (19 items) focuses on educational and cognitive growth paths related to entrepreneurial demonstrated behaviours, with keywords reflecting this, including entrepreneurship education, students, learning, intention, and behavioural outcomes. Recent research published in top-tier journals has shown that embedding AI technology and sustainability content into entrepreneurship curricula substantially increases students' entrepreneurial self-efficacy and intention.

AI technologies, including recommender systems, simulations, and adaptive learning, enabled students to align their entrepreneurial ideas with their interests and aspirations (António Porfírio et al., 2023; Zulfiqar et al., 2025). Increasingly, AI is thought of as a cognitive partner in entrepreneurship learning systems (Shepherd & Majchrzak, 2022). Cluster 3 indicates the emerging roles of formal education, experiential learning, and adaptive learning systems for the future generation of entrepreneurs who adopt a sustainable mindset, representing a shift in consciousness within our social systems.

#### *Cluster 4. Ethics, Perceptions, and AI Legitimacy in Sustainable Entrepreneurship*

Cluster 4 (17 items) includes ethical, perceptual, and legitimate concerns surrounding the entrepreneurship ecosystems of AI. Keywords include ethics, trust, perceptions, the technology acceptance model, and responsible AI. Trust and ethical perceptions of AI are increasingly recognised as a crucial moderating factor in the adoption of sustainable entrepreneurship using AI. Trust is not only an attribute of a technology but also a social construct that is influenced by social constructs of fairness, transparency, and accountability.

Reviews of empirical studies in the literature found that ethical concerns are significant in shaping trust in both the public and entrepreneurial worlds in the AI technologies affecting their legitimacy and responsible use (David et al., 2024; Ryan, 2020). Professional and organisational value-based ethical AI implementation frameworks establish both immediate and long-term legitimacy within society (Cumming et al., 2024; Klarin et al., 2024). This cluster highlights a growing recognition that technological tools must be embedded in ethical frameworks to maintain legitimacy, especially when applied to ecologically and socially sensitive entrepreneurship goals.

### 5.1 Theoretical Implications

This study enriches the theoretical discourse on entrepreneurship by advancing emerging perspectives that integrate artificial intelligence (AI) with entrepreneurial intention, cognition, and ethics. Specifically, our findings substantiate a paradigm shift: from static trait-based models of entrepreneurial behaviour to dynamic, technology-mediated cognitive frameworks, aligning with recent calls to reconceptualise entrepreneurial intention as an interactional outcome shaped by AI-enhanced environments (Jeremiah, 2025). We contribute to the technology acceptance and planned behaviour literature by demonstrating that generative AI tools do not merely assist in processing information but actively shape entrepreneurial self-efficacy, digital opportunity recognition, and entrepreneurial agency. These findings expand the Theory of Planned Behaviour by showing that perceived behavioural control is increasingly co-constructed with AI-based scaffolding systems that augment the entrepreneur's cognitive evaluation of feasibility and desirability (Duong et al., 2024; Duong & Nguyen, 2024).

Further, the research contributes to sustainability-oriented entrepreneurship theories by introducing AI-curated digital ecologies as transformative mediators of moral cognition and value salience. Prior studies highlight pro-environmental value orientation as a key driver of entrepreneurial intention (Liao et al., 2022). We extend this by theorising that algorithmic narratives and data-driven scenario modelling within AI-enhanced systems elevate sustainability salience and activate moral agency through affective feedback loops.

In parallel, our work revisits the foundations of entrepreneurship education by repositioning AI from a passive pedagogical assistant to an active cognitive partner. This aligns with constructivist models while expanding them to include human–AI collaborative knowledge construction. Generative AI facilitates immersive, adaptive learning trajectories that shape entrepreneurial cognition and foster autonomous knowledge construction (Parker et al., 2024; Guan et al., 2025).

Finally, we provide a critical theoretical extension: we propose that ethical trust and perceived legitimacy of AI systems are not external adoption drivers but internal antecedents of entrepreneurial intention itself. An intention to engage with AI as part of entrepreneurial pursuits is contingent on perceiving the algorithmic implications to be ethically fair, explainable, and emotionally aligned. We suggest an extension of the behavioural intention (BI) models to recognise trust in AI as a first-order cognitive process (Graves, 2023; Wiese et al., 2023). In doing so, we provide a refined theoretical lens for understanding, particularly, the formation of intention in the context of AI-mediated, sustainability-focused entrepreneurial activity.

### 5.2 Practical Implications

The implications of this research provide meaningful, actionable recommendations and insights for a variety of constituents engaged at the intersections of generative AI, entrepreneurship education, and sustainable innovation. For educators and institutions, this research provides an evidence-based rationale to incorporate generative AI tools (courses of engagement and learning) for entrepreneurship education, especially adaptive business simulators and AI feedback engines. These systems enhance linear coding mechanisms towards learner-driven environments that allow for individual, real-time scenario-based assessments of entrepreneurial cognition and sustainability-oriented problem legitimization, especially for novice entrepreneurs and university students (Mittal et al., 2024).

From a policy perspective, this research highlights the need for equitable digital infrastructure to facilitate and support the responsible integration of AI across entrepreneurial ecosystems. Policy objectives directly relate to the need for financial investments that improve equitable access, especially in impoverished regions and other underfunded communities, and the importance of national or institutional campaigns that promote AI literacy, encompassing not only fluency in technology but also ethical literacy (Yusuf et al., 2024). Policies designed for education or entrepreneurship training interventions must provide their users with clear frameworks for deciding on accountability, fairness, and explainability of how they use large, mounted AI systems, thereby reducing the risk of inadvertently widening existing inequalities (Wei et al., 2025).

For designers and technology developers, an AI system will need to be ethical, transparent, and adaptable, facilitating ESG (Environment, Social, Governance) principles that are situationally contextualised from what the entrepreneurial learner can and cannot do for actionable comfort. Ideally, the user interface could accommodate ethical filters and psychological profiling functions, as well as feedback on one's learning process, while taking into account the parameters of sustainability goals and the uncertainty of possible entrepreneurial success. There may be practice-based opportunities for features such as federated learning or differential privacy on data-sensitive platforms used for developing startups or exploring unknown, future entrepreneurial opportunities (Omran Almagrabi & Khan, 2025).

For students and future entrepreneurs, this research provides logical support for the evidence that generative AI systems can serve as cognitive amplifiers of existing confidence, opportunities, and iterations. Immersive, context-aware real-time simulations, when embedded within ethically bounded business modelling environments, offer learners a safe yet cognitively authentic space to navigate risk, confront failure, and grapple with ethical dilemmas before engaging in real-world managerial decision-making. However, generative AI learning engagements build even more immersive configurations of course navigation and self-regulated, unique contexts of engagement by learning to reflect on how aligned they are with their entrepreneurial intent, ecological, or social priorities when they do not have to report their learning (Ahmed et al., 2024).

In closing, the action implications of the knowledge generated by this research are clear. As educators, developers, and policymakers, we need to collaborate and coordinate to enhance the function of the systems we build from generative AI that, at scale, does decision-making for us and is both efficient and ethically sustainable. Generative AI has the potential to build a lot of possibilities, and to do so fairly, we need to be committed to a collectively designed system guided by regulators, educational developers, ethical designers, and the users themselves.

## **6. Conclusion, Limitations, and Future Research Direction**

### **6.1 Conclusion**

This research provides a holistic understanding of how generative artificial intelligence (AI) will influence our definition of intention concerning entrepreneurship, our values associated with sustainability, the establishment of educational ecosystems, and people's ethical constructs. We employed a bibliometric and cluster analysis to understand and explore four distinct yet interrelated domains: generative AI-driven cognitive aspects of entrepreneurship, sustainability-based value creation, the use of AI in pedagogical choice and design, and the ethical legitimacy of AI adoption in technology-mediated ventures.

The results illustrate that generative AI is more than an adjunct; rather, it is the cognitive co-agent in the entrepreneurial ecosystem. Significantly, it changes the underlying constructs of the intentions of opportunity recognition, self-efficacy, and how people will see controls on behaviour, even in youth and in sustainability-based forms of entrepreneurship (Duong et al., 2024; Jeremiah, 2025). The study also highlighted the importance of trust, explainability, and fairness in people's acceptance of AI's relevance in the entrepreneurial domain and called upon researchers to start rethinking ethically embedded cognitive frameworks (Graves, 2023).

### **6.2 Limitations**

Despite its contributions, the study carries several limitations. First, the bibliometric data were exclusively sourced from Scopus, which may exclude frontier research in early-stage journals or region-specific studies. Research has emphasised the need to triangulate with Web of Science and domain-specific repositories to avoid potential bias in innovation studies across global entrepreneurship systems (Wang & Zhang, 2024). Second, future studies should operationalise ethical AI frameworks and integrate fairness audits and governance protocols into empirical models. Using explainable artificial intelligence (XAI) in entrepreneurship platforms can cast light on how algorithmic approaches diversify conceptions of adoption and legitimacy (Weidener & Fischer, 2024).

Future studies must thus be focused on technological innovation of the implementation of artificial intelligence (AI) and generative artificial intelligence (Gen AI) in regard to education, identification of opportunities, and ethical simulation through deep learning. The combination of Structural Equation Modelling (SEM) and Artificial Neural Network (ANN) brings knowledge regarding AI and how it is anthropomorphised and regarded as intelligent. Furthermore, an interesting relationship is observed between the adoption of responsible technologies and social sustainability, which leads to the apparent lack of emotional adaptive architecture (Al-Emran et al., 2024).

### 6.3 Future Research Directions

Building on our insights and limitations, we suggest four promising directions for future research. First, longitudinal studies are crucial for evaluating the sustained impact of generative AI on entrepreneurial performance, digital strategy alignment, and sustainability awareness. Evidence from education-centred entrepreneurship ecosystems suggests that generative AI has a significant impact on task performance, perceived tool alignment, and entrepreneurial success over time (Marchena Sekli & Portuguese-Castro, 2025). Second, the methodological reliance on co-citation and cluster analysis emphasises macro-level knowledge structures but does not capture in-depth contextual or qualitative dynamics of AI use in entrepreneurship. The temporal cutoff also restricts the capture of rapidly emerging trends in generative AI models, such as GPT-5 or multimodal platforms, which are likely to further reshape the ecosystem (Wiese et al., 2023). Finally, while we conceptually address ethical implications—e.g., bias, transparency, and fairness—our study does not empirically test how these factors impact AI adoption across diverse socio-cultural or institutional contexts. Such omission limits practical generalisation and calls for more granular, cross-sectional, and mixed-method investigations.

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**Dong LI**

ORCID: <https://orcid.org/0009-0002-1066-5637>

**Guoxi XUE**

ORCID: <https://orcid.org/0009-0006-4992-3799>

**Shaowei MIAO**

ORCID: <https://orcid.org/0009-0006-7976-9390>

**Xinyue QIAO**

ORCID: <https://orcid.org/0009-0008-9822-4948>

**Valentine Kirimi MURIIRA**

ORCID: <https://orcid.org/0009-0002-6466-5637>

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