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Pro-environmental personal norms and subjective norms related to AI-driven green entrepreneurship intention: A qualitative insight to explore students in higher education institutions

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ABSTRACT

As artificial intelligence (AI) continues to be widely integrated into global economic, social, and environmental governance, its role in promoting sustainable entrepreneurship has garnered increasing scholarly attention. This research aims to uncover the predictors affecting students' pro-environmental personal norms (EPNs) and subjective norms (SNs) related to AI-Driven Green Entrepreneurship Intention, thereby to propose a qualitative conceptual framework to shape the green entrepreneurial intentions. This study utilized semi-structured interviews to collect 30 empirical data from students, faculty members, and AI-driven green entrepreneurs. The data were analyzed through Nvivo 12, following grounded theory method with a three-stage coding process—open coding, axial coding, and selective coding—to reconceptualise the AI-driven sustainable entrepreneurship norms. This study explores how students in higher education develop pro-environmental personal norms (EPNs) and subjective norms (SNs) within AI-driven green entrepreneurship. The findings reveal that (1) higher education institutions cultivate environmental values and entrepreneurial awareness through AI-powered courses, incubators, and sustainability programs; (2) social influence, including mentorship, peer engagement, and industry expectations, reinforces subjective norms, shaping students' green entrepreneurial intentions; and (3) AI technology, policy support, and practical challenges influence the transition from environmental awareness to entrepreneurial action, with financial and technological constraints limiting implementation. This study not only enriches the entrepreneurship theory, but provides practical insights for higher education institutions, policymakers, and businesses to enhance AI-enabled green entrepreneurial education and policy frameworks.

Keywords: Artificial intelligence (AI); sustainable entrepreneurship; higher education; subjective norms; pro-environment, personal norms (EPNs).

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INTRODUCTION

As the world's second-largest economy, China continues to experience significant employment challenges despite sustained economic growth. The employment pressure faced by university graduates has become a focal point of concern across various sectors of society (Qin et al., 2024). In recent years, structural adjustments in industries and shifts in market demand have led to a gradual reduction in traditional employment opportunities, intensifying competition among university graduates in the labor market (Liu et al., 2024; Xiang et al., 2023). Against this backdrop, entrepreneurship has emerged as a crucial means of alleviating employment pressures, not only by

generating new job opportunities but also by driving economic transformation and industrial upgrading. However, entrepreneurial activities are often accompanied by resource consumption and environmental pollution, as some startups prioritize economic gains at the expense of sustainable development goals (SDGs) (Feng et al., 2024; Tiba et al., 2021). Therefore, striking a balance between fostering entrepreneurship and ensuring environmental sustainability, particularly by promoting green entrepreneurial models, has become a critical issue of concern for both academia and policymakers.

Artificial Intelligence (AI), as one of the most transformative technologies of the 21st century, is rapidly reshaping global economic, social, and environmental governance systems. AI technology has made significant advancements in water resource management, environmental monitoring, and carbon emission reduction optimization (Chen et al., 2023; Francisco and Linnér, 2023). These developments provide technological support for the United Nations' Sustainable Development Goals (SDGs), particularly in the areas of clean energy and ecological conservation. However, AI technology itself also poses challenges to environmental sustainability. Without effective measures, AI-related electronic waste will increase 1,000-fold by 2030, reaching approximately 1.2 to 5 million tons. This trend underscores the urgent need to balance AI-driven innovation with sustainable development. Moreover, the role of AI in green innovation and entrepreneurship is garnering increasing attention (He et al., 2025; Kar et al., 2022).

Over 60% of technology startups have integrated AI into their sustainability strategies to enhance resource efficiency and reduce carbon emissions. However, despite the advantages AI presents for environmental sustainability, its integration into higher education systems, particularly in fostering future entrepreneurs' environmental responsibility, remains underexplored (Alzoubi and Mishra, 2024; Duong et al., 2024).

AI-driven green entrepreneurship utilizes artificial intelligence to optimize resource use, reduce carbon emissions, and drive eco-innovation, aligning economic growth with environmental sustainability (Appio et al., 2024). Advances in AI-driven data analytics, predictive modeling, and automation provide vital support for green startups. For instance, AI-powered energy management reduces energy waste by 30%, while precision agriculture lowers resource consumption by 20% (Zong and Guan, 2024). These innovations enhance both sustainability and market competitiveness. The significance of AI-driven green entrepreneurship arises from environmental and economic challenges. China accounted for 30% of global carbon emissions in 2023, highlighting the need for AI-based carbon management. Meanwhile, the global AI market for environmental applications is projected to grow 28% annually through 2030 (Bolón-Canedo et al., 2024; Jorzik et al., 2024). However, its success depends on entrepreneurs' AI proficiency and environmental awareness. Many green startups face talent shortages and infrastructure gaps (Upadhyay et al., 2023). Thus, fostering AI-driven green entrepreneurship requires higher education and policy support to equip future entrepreneurs with AI skills and sustainability awareness, ensuring meaningful contributions to the green economy.

In the higher education sector, AI is profoundly transforming teaching methodologies, curriculum design, and students' innovation capabilities. AI-powered intelligent learning systems and big data analytics are reshaping the educational ecosystem in higher education, fostering personalized learning and interdisciplinary innovation (Ramkissoon, 2024). Over 90% of undergraduate students in the UK use AI tools for learning, prompting universities to reassess their evaluation methods to ensure fairness and integrity (Gonsalves, 2024). In response to these developments, HEIs must not only adjust their curricula to accommodate AI technologies but also guide students in developing a comprehensive understanding of AI's role in sustainable development. Currently, there is a lack of qualitative research on how higher education environments shape students' environmental personal norms and subjective norms in relation to AI-driven green entrepreneurship (Duong et al., 2024). Hence, this study aims to explore how students in higher education institutions develop environmental personal norms and subjective norms related to AI-driven green entrepreneurship. Specifically, this research focuses on three key questions:

1. What are the drivers foster the environmental personal norms and subjective norms?
2. What are the roles of environmental personal norms and subjective norms play in the formation of AI-driven green entrepreneurship intentions?
3. How do higher education systems, university curricula, and policy support influence students' environmental personal norms and subjective norms?

LITERATURE REVIEW

Green entrepreneurship

Green entrepreneurship and sustainable entrepreneurship play a crucial role in promoting environmental sustainability and economic development, with both concepts being interconnected yet distinct. Green entrepreneurship refers to integrating environmental considerations into business strategies by developing eco-friendly products, reducing carbon emissions, and enhancing resource efficiency to achieve sustainable development goals (SDGs). This concept emphasizes the role of green innovation in improving corporate competitiveness within environmentally conscious

markets (Zhang et al., 2024). In contrast, sustainable entrepreneurship encompasses a broader scope, addressing not only environmental concerns but also social and economic dimensions, ensuring long-term viability while fulfilling corporate social responsibility (CSR) and promoting social equity (Kabbara, 2025b).

Extensive research has explored the impact of green entrepreneurial orientation on corporate competitiveness. Studies have shown that green entrepreneurial orientation significantly enhances sustainable competitive advantage, with green organizational identity and green innovation serving as chain mediators in this relationship (Zhang et al., 2024). Structural equation modeling (SEM) analysis based on enterprise survey data has indicated that firms with a strong green entrepreneurial orientation are more likely to develop a sense of green organizational identity, which further fosters green innovation, ultimately improving their competitive positioning in the market (Zhang and Li, 2021).

The role of education in fostering green entrepreneurship has also received increasing academic attention. Research has found that green entrepreneurship education effectively enhances university students' entrepreneurial intentions, with emotional intelligence and entrepreneurial self-efficacy acting as partial mediators (Yu et al., 2024). The integration of sustainability-focused modules into entrepreneurship curricula has been shown to significantly improve students' abilities to engage in green business ventures (Liang et al., 2025). Furthermore, educational management strategies in vocational institutions play an essential role in shaping sustainable entrepreneurship development, with systematic entrepreneurial training, government policy support, and practice-oriented teaching methods contributing to students' capacity for green entrepreneurship (Denphitat et al., 2025).

From a policy perspective, transformative entrepreneurship has emerged as a key driver of global sustainability. Entrepreneurs leveraging circular economy principles and green technologies have contributed significantly to sustainable development by adopting innovative business models (Kabbara, 2025b). Additionally, studies have shown that the social mindset of entrepreneurs significantly influences the adaptability and innovation capacity of private enterprises, with long-term sustainability strategies improving resilience in dynamic market conditions (Bai, 2025).

Despite the significant potential of green entrepreneurship, several challenges hinder its large-scale adoption. Studies indicate that financial constraints, technological limitations, and regulatory uncertainties remain the primary barriers to green entrepreneurship (Denphitat et al., 2025). Moreover, the role of female entrepreneurs in sustainable entrepreneurship remains underexplored. While women-led enterprises tend to prioritize social responsibility and environmental sustainability, they continue to face considerable challenges in securing funding and accessing resources (Kabbara, 2025a).

In summary, existing research highlights the importance of green and sustainable entrepreneurship in advancing environmental sustainability and economic growth. Green entrepreneurship focuses on leveraging technological innovation to create eco-friendly business models, while sustainable entrepreneurship expands this framework to include broader social and economic considerations. However, challenges related to financing, policy frameworks, and gender disparities remain critical areas for future research. Further studies should explore how policy interventions and educational frameworks can enhance the green entrepreneurial ecosystem, ensuring a more inclusive and sustainable business environment.

AI-driven green entrepreneurship

Artificial Intelligence (AI) has become an essential driver of green entrepreneurship and sustainable business model innovation. As AI technology continues to be integrated into resource optimization, supply chain management, circular economy, low-carbon production, and renewable energy integration, its role in fostering sustainable entrepreneurship has gained significant scholarly attention. AI not only enhances enterprises' adaptability to green transitions but also encourages entrepreneurs to incorporate sustainability into business model design (Jorzik et al., 2024; Mondal et al., 2023; Seyyedi et al., 2024).

AI-driven sustainable business models are often aligned with circular economy principles, promoting closed-loop systems in waste management, supply chain optimization, and low-carbon production. In agriculture and manufacturing, AI combined with digital twin technology has enabled precision irrigation, intelligent manufacturing, and energy optimization, effectively reducing carbon footprints (Cesco et al., 2023; Seyyedi et al., 2024).

AI plays a multifaceted role in enhancing the sustainability of green entrepreneurship. It facilitates the development of green dynamic capabilities, allowing firms to swiftly adjust their strategies in response to environmental changes (Hällerstrand et al., 2023). Furthermore, AI-powered decision support systems enable entrepreneurs to access real-time environmental data, thus facilitating more precise decision-making. For instance, AI has been leveraged in renewable energy and smart grid management to optimize supply-demand matching, enhance grid stability, and minimize energy waste (Ahmad et al., 2022). Moreover, AI-driven sustainable supply chain management significantly enhances logistics efficiency, carbon footprint tracking, and intelligent inventory control, ensuring minimal resource wastage (Huang and Mao, 2024). In the fashion

industry, AI has been utilized for fabric optimization and smart manufacturing, allowing companies to reduce raw material consumption while mitigating environmental pollution. On a broader scale, AI-powered global logistics networks contribute to reduced transportation-related emissions and improved energy efficiency (Pawar et al., 2025; Ramos et al., 2023).

AI is also instrumental in advancing low-carbon economies and environmental sustainability initiatives. As part of global Net Zero Carbon strategies, AI is widely employed in carbon emission monitoring, carbon trading optimization, low-carbon manufacturing, and energy management. AI applications in smart grids, renewable energy integration, and carbon credit trading have demonstrated the potential to improve energy efficiency and promote corporate sustainability. In the financial sector, AI is enhancing Environmental, Social, and Governance (ESG) investments, enabling investors to make more accurate and sustainable financial decisions (Hua et al., 2022; Lim, 2024; Wang et al., 2024).

Despite these advantages, AI adoption in green entrepreneurship presents several challenges. The high initial investment cost and accessibility constraints make it difficult for small and medium-sized green startups to fully integrate AI technology. Ethical concerns related to data security, privacy, and algorithmic transparency remain significant barriers to AI deployment in sustainability initiatives. Additionally, the reliance on high-quality datasets and potential algorithmic biases could introduce decision-making errors, affecting sustainability strategies (Holzinger et al., 2021; Liu, 2023; Vetrò et al., 2021).

However, the potential of AI in green entrepreneurship remains substantial. Future policies and corporate strategies should focus on government incentives, investment support, and research and development in AI-driven green technologies to ensure broader adoption. Strengthening government support for AI-enabled green technology innovation and establishing comprehensive AI sustainability policies could further accelerate AI's role in fostering sustainable entrepreneurship (Shaik et al., 2024).

Existing research highlights AI's contributions to business model optimization, supply chain sustainability, and low-carbon economic transformation. However, the intersection between AI and social norm formation in green entrepreneurship, particularly in higher education contexts, remains underexplored (Anton and Mansingh, 2025; Hong and Xiao, 2024; Tseng and Lin, 2024). However, it is essential to investigate how higher education institutions leverage AI to enhance entrepreneurs' environmental responsibility and social influence, providing a more comprehensive framework for sustainable entrepreneurship.

Pro-environmental personal norms and Green entrepreneurship

Pro-environmental personal norms (PPNs) refer to an individual's moral responsibility toward environmental protection. When individuals become aware of the environmental impact of their actions and perceive an obligation to adopt pro-environmental behaviors, they are more likely to engage in sustainable practices (Momenpour et al., 2024; Shah et al., 2021). This concept originates from the Norm Activation Theory (NAT), which posits that pro-environmental personal norms are activated when individuals develop a high awareness of consequences (AC) and assume ascription of responsibility (AR) for environmental issues, thereby promoting pro-environmental behavior (Lin et al., 2022). In the context of entrepreneurship, pro-environmental personal norms influence not only individual environmental behavior but also play a critical role in decision-making processes related to green entrepreneurship (Meng et al., 2023).

Pro-environmental personal norms significantly impact green entrepreneurial intentions and behaviors. Individuals with a strong sense of environmental responsibility are more inclined to adopt sustainable entrepreneurial models and prioritize the development of green products and services (Ameer and Khan, 2023). Furthermore, pro-environmental personal norms enhance green entrepreneurial intention by shaping environmental attitudes and perceived behavioral control (Majeed et al., 2023). Pro-environmental personal norms strengthen subjective norms and behavioral intentions, thereby increasing entrepreneurs' awareness of sustainability in business decision-making (Savari et al., 2023).

In the context of higher education, fostering pro-environmental personal norms is crucial for shaping students' green entrepreneurial behavior. Green entrepreneurship education is considered an effective means of enhancing students' environmental awareness and sense of responsibility (Qazi et al., 2021). Integrating sustainability-related content, such as eco-innovation and circular economy, into entrepreneurship curricula significantly strengthens students' pro-environmental personal norms and encourages them to implement green business models in their future ventures (Ameer and Khan, 2023). Additionally, social networks and social influence play a vital role in shaping pro-environmental personal norms. Entrepreneurs exposed to green business models through social networks are more likely to develop a sense of environmental responsibility and adopt sustainable strategies in their entrepreneurial activities (Riaz et al., 2024).

Despite the well-established link between pro-environmental personal norms and green entrepreneurship, challenges persist in their practical application. On one hand, individuals' environmental responsibility may be constrained by cultural background, policy support, and market conditions (Liu et al., 2021). In the absence of government incentives or societal recognition, the activation of pro-environmental personal

norms may be limited. On the other hand, existing studies have not sufficiently explored the integration of pro-environmental personal norms with technological innovation, which could further advance green entrepreneurship intention (Savari et al., 2023).

Subjective norms and sustainable entrepreneurship

Subjective norms play a crucial role in shaping individual behavior, particularly in the domains of environmental sustainability and entrepreneurship. Subjective norms refer to an individual's perception of social expectations, encompassing the influence of societal environments, cultural contexts, and group identities on decision-making and behavior (Yang et al., 2024). In the context of sustainable entrepreneurship, subjective norms reflect societal expectations regarding entrepreneurs' engagement in sustainable practices, including guidance from family, peers, educational institutions, and government policies (Yasir et al., 2023).

The impact of subjective norms on entrepreneurial intention has become a key area of research in entrepreneurship studies. According to the Theory of Planned Behavior (TPB), entrepreneurial decision-making is influenced by attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991). Subjective norms represent the social pressures individuals experience, such as encouragement or constraints from family, friends, peers, and broader societal influences (Bazan, 2022). Individuals in environments with strong pro-entrepreneurial cultures are more likely to perceive positive subjective norms, thereby increasing their entrepreneurial intentions (Barrera-Verdugo et al., 2024). Furthermore, entrepreneurship education, social networks, and government policies can reinforce the impact of subjective norms, making individuals more inclined to pursue entrepreneurship as a career path (Maheshwari and Kha, 2022).

In the context of sustainable entrepreneurship, subjective norms are also regarded as a significant determinant of entrepreneurial decisions (Romero-Colmenares and Reyes-Rodríguez, 2022). When society exhibits a strong emphasis on environmental sustainability, individuals are more likely to adopt green entrepreneurship as a response to social expectations. Particularly in higher education settings, advocacy for sustainable entrepreneurship by educators, peers, social media, and policymakers enhances students' environmental responsibility, increasing their inclination to establish green businesses (Prieto-Sandoval et al., 2022). Additionally, subjective norms not only influence individual entrepreneurial choices but also shape broader societal values, promoting sustainable business practices (Romero-Colmenares and Reyes-Rodríguez, 2022).

Despite the recognized role of subjective norms in entrepreneurship and sustainable entrepreneurship, several research gaps remain. Despite the acknowledged influence of subjective norms on sustainable entrepreneurship, research has yet to sufficiently uncover the specific mechanisms through which these norms shape individual entrepreneurial intentions. Existing studies primarily focus on general entrepreneurial behavior, offering limited insights into how social expectations and interpersonal interactions foster sustainability-oriented decisions within entrepreneurial contexts. Moreover, although prior research has recognized the importance of entrepreneurship education, how educational systems actively optimize subjective norms to promote green entrepreneurship intentions remains inadequately addressed (Galvão et al., 2024; Khan et al., 2021; Romero-Colmenares and Reyes-Rodríguez, 2022).

Higher education shaping AI-driven green entrepreneurship intentions

Higher education plays a crucial role in shaping students' environmental personal norms (EPNs) and subjective norms (SNs), particularly in the context of sustainable entrepreneurship. Universities not only impart sustainability knowledge through curriculum design and pedagogical approaches but also influence students' entrepreneurial mindset and sense of social responsibility through social interactions and institutional policies (Cui et al., 2021). With the increasing integration of Artificial Intelligence (AI) into higher education, research has begun to explore how AI enhances entrepreneurial decision-making, cultivates students' environmental responsibility, and fosters the development of a green entrepreneurship culture (Han et al., 2024).

Higher education always plays a vital role in fostering AI-driven green entrepreneurship intentions. First, the application of AI in entrepreneurship education has been found to enhance students' entrepreneurial self-efficacy, increasing their confidence in pursuing sustainable business ventures (Ioannou and Retalis, 2025). AI-powered tools, such as ChatGPT, optimize entrepreneurial decision-making and improve students' understanding of green business models, thereby strengthening their sustainable entrepreneurial intentions (Duong et al., 2024). Moreover, AI-enabled personalized learning systems allow students to tailor entrepreneurship courses based on their interests, improving their comprehension of sustainable entrepreneurship concepts (Suryanarayana et al., 2024).

Additionally, subjective norms play a significant role in shaping AI-driven green entrepreneurship intentions. Mentorship, peer influence, and policy frameworks influence students' perceptions of AI in green entrepreneurship, subsequently shaping their

entrepreneurial intentions (Wang et al., 2024). Furthermore, university-driven initiatives such as green campus policies, startup incubators, and government support programs positively impact students' environmental personal norms and sustainable entrepreneurial engagement (Borrero and Yousafzai, 2024; Galvão et al., 2024).

Despite the recognized importance of higher education in shaping AI-driven green entrepreneurship intentions, several research gaps remain.AI has been widely recognized for enhancing entrepreneurial competence, and limited research has explored how AI shapes students' environmental personal norms and subjective norms within higher education settings. Moreover, while the role of AI in entrepreneurship education is well established, how AI influences social norm development and how these norms translate into sustainable entrepreneurial behavior remains underexplored (Duong et al., 2024; Ghouse et al., 2024; Nguyen and Nguyen, 2024).

METHOD

Data collection

The study employs purposeful sampling and snowballing methods to recruit 30 participants representing different stakeholders in AI-driven entrepreneurship and sustainability education within higher education institutions (Pan and Tang, 2020). Data saturation was reached at this sample size, as no new concepts or categories emerged from the interviews, indicating that additional data collection would likely yield redundant information rather than contribute to theoretical development. Participants are drawn from a range of university contexts, including comprehensive universities, technology-focused institutions, and business schools, ensuring a diverse and representative sample. The participant composition consists of university students (15 participants, coded as A1–A15), university faculty members (10 participants, coded as B1–B10), and AI-based green entrepreneurs or investors (5 participants, coded as C1–C5).

This participant composition was selected to ensure a comprehensive perspective on AI-driven green entrepreneurship, capturing insights from students as potential future entrepreneurs, faculty members as educators shaping entrepreneurial and sustainability norms, and AI-based green entrepreneurs or investors as practitioners who apply these concepts in real-world business environments, thereby enabling a well-rounded analysis of the interactions between education, technology, and sustainable entrepreneurship.

Data collection is conducted through semi-structured interviews, designed to allow flexibility while ensuring consistency across participants. Each interview lasts between 30 and 45 minutes and is conducted either online (via platforms such as Zoom or Microsoft Teams) or in person, depending on participants' availability and preference. With participants' consent, all interviews are audio-recorded and transcribed verbatim to ensure accuracy and reliability in data analysis.

A total of approximately 500,000 words of interview transcripts were collected. The transcriptions were initially generated using AI-assisted transcription software (Otter.ai and Microsoft Azure Speech to Text) and were subsequently reviewed manually for accuracy. To facilitate data analysis and interpretation, Chinese transcripts were translated into English using a combination of AI-based translation tools (DeepL and Google Translate) and manual verification by bilingual researchers to ensure semantic accuracy and contextual alignment. Both the original transcripts and translated versions were cross-checked to maintain consistency and reliability in qualitative coding and analysis.

Data coding and analytical tools

Grounded Theory is an inductive qualitative research approach designed to develop theories emerging from systematically analyzed data. Unlike traditional hypothesis-driven studies, this method emphasizes data-driven theory construction, wherein concepts and theoretical models are derived from empirical observations rather than predefined assumptions. The analytical process involves three main coding stages: open coding, where key concepts are identified; axial coding, which establishes relationships between categories; and selective coding, where core themes are synthesized into a theoretical framework (Strauss and Corbin, 1998). This iterative process enables researchers to build a structured understanding of complex social phenomena based on rich qualitative data.

The application of Grounded Theory in this study is particularly valuable for several reasons. Firstly, it provides a dynamic approach to investigating the formation of entrepreneurial norms in an emerging field where existing theoretical models may be insufficient. Secondly, it allows for theory generation, offering novel insights into how higher education fosters students' sustainability commitments and entrepreneurial decision-making. Thirdly, Grounded Theory ensures data-driven interpretation, making the analysis more responsive to participants' experiences, thereby capturing the complexity of the interaction between AI, entrepreneurship, and sustainability. By adopting this methodology, this study aims to construct a conceptual model that explains how AI adoption in university education contributes to students' engagement in sustainable entrepreneurship.

To ensure systematic data analysis, this study employs

Nvivo 12, a widely recognized qualitative data analysis software, which facilitates efficient organization, coding, and interpretation of interview transcripts. The use of Nvivo enhances the transparency, rigor, and reproducibility of the analysis by allowing researchers to systematically classify and retrieve thematic patterns within large datasets.

The study follows a three-stage coding process based on Grounded Theory principles. The first stage, open coding, involves the initial identification of key themes emerging from the interview data, allowing for an exploratory categorization of concepts related to AI-driven green entrepreneurship. The second stage, axial coding, establishes connections between identified categories, revealing relationships among education, AI adoption, sustainability norms, and entrepreneurial intention. The final stage, selective coding, refines and integrates these relationships into a cohesive theoretical framework, demonstrating how higher education facilitates the development of students' environmental personal norms and subjective norms in relation to AI-driven sustainable entrepreneurship.

RESULTS

Open coding

The open coding phase systematically identifies key factors influencing the formation of environmental personal norms (EPNs) and subjective norms (SNs) among university students in the context of AI-driven green entrepreneurship. Through an in-depth analysis of interview data, twelve primary themes emerge, spanning four dimensions: education, technology, social influence, and entrepreneurship. These themes illustrate how higher education, AI technologies, policy support, and social influences collectively shape students' attitudes, beliefs, and behaviors toward sustainable entrepreneurship.

The role of AI in entrepreneurship education highlights how AI technologies enhance students' understanding of sustainable business models. The application value of AI in entrepreneurial practice explores the impact of AI on business decision-making, market analysis, and environmental impact assessments in shaping students' entrepreneurial intentions. University sustainability policies examine the extent to which institutions integrate AI and sustainable entrepreneurship into academic programs and their effectiveness.

Social influence investigates the role of peers, mentors, and university administration in shaping students' perceptions of AI-driven sustainable entrepreneurship. Environmental awareness and value formation examine how students develop a sense of environmental responsibility through education and practical exposure. Challenges in AI adoption address technical barriers, knowledge accessibility, and resource constraints that may hinder students from applying AI to green entrepreneurship.

Furthermore, entrepreneurial mindset development reflects how higher education fosters students' problem-solving skills, creativity, and adaptability through AI-powered entrepreneurship training. Green startup incubation support explores how university incubators, funding, and mentorship contribute to AI-driven sustainable entrepreneurship. AI ethics and trust assess concerns related to AI transparency, fairness, and ethical decision-making in sustainability-oriented enterprises.

Governmental and institutional support evaluates the role of national policies, research funding, and AI-driven sustainability initiatives in fostering entrepreneurial opportunities. AI integration in entrepreneurial learning examines how AI enables personalized, data-driven, and innovative learning experiences that enhance entrepreneurial education.

Table 1 provides a structured summary of the open coding results, incorporating representative statements from interview participants that illustrate how these themes are reflected in practice. These findings lay the groundwork for further theoretical development and provide a basis for examining the interrelationships among these key factors.

Table 1. Open coding results.

Theme	Keywords
Role of AI in Entrepreneurship Education	AI-driven analytics, business simulation, green business models, market analysis, sustainability decision-making
The Application Value of AI in Entrepreneurial Practice	AI forecasting, sustainability risk management, resource efficiency, waste reduction, energy optimization
University Sustainability Policies	AI-driven projects, funding support, policy encouragement, research application, structured guidance
Social Influence	Peer motivation, mentorship, investor expectations, AI-driven sustainability projects

Table 1. Continue.

Environmental Awareness and Value Formation	Sustainability courses, AI case studies, environmental responsibility, climate change data, green entrepreneurship commitment
Challenges in AI Adoption	Technical expertise gap, high implementation costs, lack of AI training, student startup barriers
Entrepreneurial Mindset Development	AI-powered simulations, problem-solving strategies, adaptability, mindset shift, sustainability alignment
Green Startup Incubation Support	AI-based mentorship, startup resources, grants for AI-driven sustainability, university incubators
AI Ethics and Trust	Trust in AI, ethical decision-making, transparency, algorithm bias, environmental impact assessment
Governmental and Institutional Support	AI-driven entrepreneurship policies, research grants, university-business collaboration, policy incentives
AI Integration in Entrepreneurial Learning	AI-based simulations, adaptive learning tools, personalized training, data-driven strategy development

Figures 1 and 2 provide a visual and quantitative analysis of the key themes emerging from participant interviews on AI-driven green entrepreneurship. Figure 1, illustrates the most frequently occurring terms, with “AI,” “green,” and “entrepreneurial” being the most prominent, highlighting the central role of artificial intelligence in shaping sustainable business ventures. Other significant terms such as “education,” “policy,” “norms,” and “technology” suggest that institutional frameworks, social expectations, and technological advancements are key factors influencing sustainable entrepreneurship. Figure 2, the word frequency chart, quantifies these occurrences, confirming that “AI” appears most frequently, followed by “green,” “entrepreneurial,” and “sustainable”—reinforcing the study’s core focus on technology-driven sustainability in business. The presence of “policy,” “higher education,” and “social” further indicates the importance of governance, academic environments, and peer influences in shaping entrepreneurial intentions. Together, these visualizations substantiate the thematic framework established in the coding process, providing empirical support for analyzing the interactions between AI, sustainability, and entrepreneurship.

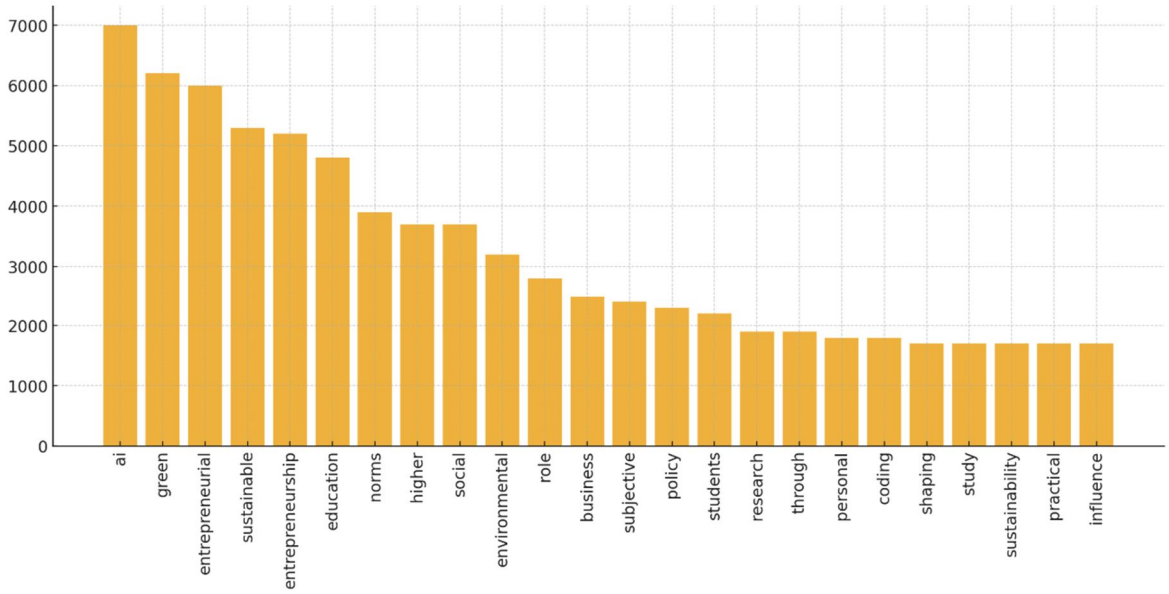

Figure 1. Word cloud diagram.

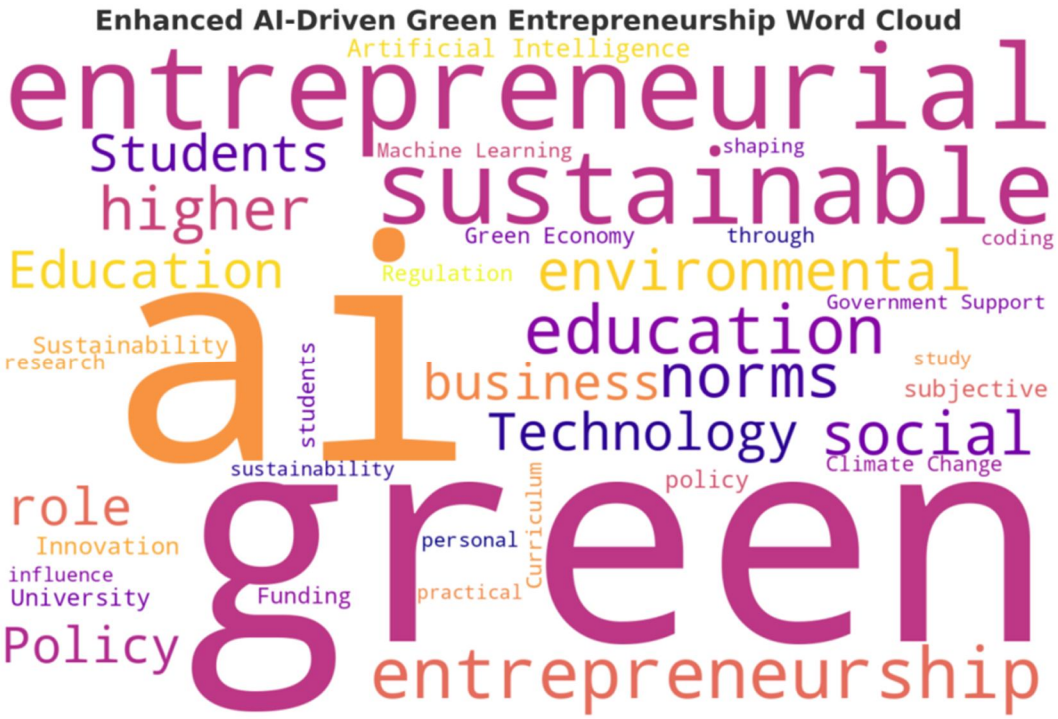

Figure 2. Word frequency diagram.

Axial coding

Building upon the open coding phase, axial coding consolidates various categories into broader, interconnected themes, revealing the key mechanisms through which higher education influences the formation of environmental personal norms (EPNs) and subjective norms (SNs) among university students in AI-driven green entrepreneurship. Through a systematic analysis of the data, five core themes are identified: Higher Education and AI Entrepreneurship Training, Social Influence and Value Formation, AI-Enabled Sustainable Entrepreneurship, Policy and Institutional Support, and Practical Challenges in AI Entrepreneurship. Each theme represents a critical dimension shaping the normative development of students in AI-driven sustainability-focused entrepreneurship.

Higher Education and AI Entrepreneurship Training highlights the role of universities in shaping students' entrepreneurial mindset, innovation capacity, and sustainability awareness. AI-integrated entrepreneurship courses applied learning projects, and business incubation programs provide students with practical exposure to AI-driven sustainable business models. Interview data reveal that personalized AI-driven entrepreneurship training enhances students' strategic decision-making skills and deepens their understanding of sustainable business ecosystems.

Social Influence and Value Formation examines how social networks, mentors, peers, and industry trends shape students' environmental responsibility and entrepreneurial choices. Family, educators, entrepreneurial role models, and public discourse play a crucial role in shaping students' subjective norms and behavioral intentions. Social influence functions not only through direct experience but also via indirect social recognition, where students adjust their entrepreneurial aspirations based on the expectations and behaviors of their social circles.

AI-Enabled Sustainable Entrepreneurship explores how AI contributes to market analysis, business forecasting, and resource optimization, enhancing the feasibility of sustainable entrepreneurship. AI-powered tools optimize supply chain management, energy efficiency assessments, and green product development, providing entrepreneurs with data-driven insights for sustainable decision-making. However, the real impact of AI adoption depends on students' technological adaptability and trust in AI-powered business solutions.

Policy and Institutional Support emphasizes the role of government agencies, universities, and industry bodies in promoting AI-driven green entrepreneurship through funding opportunities, policy incentives, and incubator programs. National strategies on AI and sustainability, university-led green entrepreneurship initiatives, and an

improving investment climate all significantly influence students' willingness to engage in AI-driven sustainable businesses.

Practical Challenges in AI Entrepreneurship uncover the technical, ethical, financial, and market adaptation barriers that hinder the practical implementation of AI-driven sustainable entrepreneurship. While AI technology offers significant advantages, many students and early-stage entrepreneurs struggle with technical complexity, data security concerns, and the difficulties of integrating AI into viable business models.

Table 2 presents the results of axial coding, illustrating how these interconnected factors collectively shape students' normative development in AI-driven green entrepreneurship.

Table 2. Axial coding results.

Axial theme	Associated open coding categories
Higher Education and AI Entrepreneurship Training	Role of AI in Entrepreneurship Education; The Application Value of AI in Entrepreneurial Practice
Social Influence and Value Formation	Social Influence; Environmental Awareness and Value Formation
AI-Enabled Sustainable Entrepreneurship	The Application Value of AI in Entrepreneurial Practice; AI Integration in Entrepreneurial Learning
Policy and Institutional Support	Governmental and Institutional Support; University Sustainability Policies
Practical Challenges in AI Entrepreneurship	AI Ethics and Trust; Challenges in AI Adoption

Selective coding

At the selective coding stage, this study further consolidates the results of axial coding to construct a systematic analytical framework, elucidating how higher education influences the development of pro-environmental personal norms (EPNs) and subjective norms (SNs) in AI-driven green entrepreneurship among university students. By integrating the five key dimensions of higher education, social influence, AI technology, policy support, and practical challenges, this phase refines three core pathways, revealing how these factors collectively shape students' normative development and entrepreneurial behavior in the AI-driven green entrepreneurship context.

The norm formation pathway emphasizes the role of higher education in shaping green entrepreneurial values, environmental responsibility, and AI technology adoption awareness. The integration of AI entrepreneurship education not only equips students with technical skills but also fosters a systematic understanding of sustainable entrepreneurship through structured curricula and practical incubation programs, prompting them to prioritize environmental considerations in their entrepreneurial decisions. The innovative and entrepreneurial ecosystem provided by universities—including policy guidance, industry collaborations, curriculum design, and entrepreneurship competitions—significantly influences students' perception and willingness to engage in AI-driven green entrepreneurship. This normative formation impacts not only theoretical knowledge but also entrepreneurial thinking and practical competencies, leading students to adopt business models that align with sustainable development principles.

The social interaction pathway explores how social factors such as family, mentors, peers, and industry expectations influence students' normative recognition in AI-driven green entrepreneurship. Social influence plays a crucial role in shaping norms, particularly in the early stages of entrepreneurship, where social interactions can either reinforce or weaken students' recognition of AI-driven green entrepreneurship norms. Family financial support and values impact students' willingness to pursue sustainable entrepreneurship, while mentor guidance and industry role models enhance students' confidence in entrepreneurship. Additionally, peer communication and collaboration facilitate information sharing and innovation in entrepreneurial practices. Furthermore, industry trends and market expectations implicitly shape students' perceptions of AI's trustworthiness and applicability in green entrepreneurship.

The practice transition pathway highlights how AI technology, policy support, and real-world entrepreneurial challenges collectively determine the transformation of EPNs and SNs into actual entrepreneurial behaviors. Although higher education and social influences contribute to fostering students' awareness of green entrepreneurship, whether this awareness translates into actual practice is subject to multiple constraints in the external environment. The feasibility and effectiveness of AI applications in entrepreneurship—such as their ability to optimize business models and enhance decision-making—directly impact students' willingness to integrate AI into their ventures. Moreover, policy incentives, including financial subsidies, tax benefits, and green certification mechanisms, influence the transition from

normative formation to concrete entrepreneurial actions. However, AI-driven green entrepreneurship still faces significant practical challenges, including technological barriers, difficulties in accessing funding, market uncertainty, and ethical concerns surrounding AI applications. These factors may serve as critical obstacles preventing the transformation of normative beliefs into entrepreneurial actions.

Table 3 presents the selective coding framework, illustrating how these pathways influence the research topic.

Table 3. Selective coding results.

Core pathway	Associated axial themes	Open coding themes
Norm Formation Pathway: How Higher Education Shapes Students' Green Entrepreneurial Values	Higher Education as a Norm Formation Mechanism; Policy and Institutional Support	Role of AI entrepreneurship education; Impact of business incubation programs; How university policy support promotes entrepreneurial intention; Channels for acquiring entrepreneurial knowledge
Social Interaction Pathway: How Social Influence Mediates the Formation and Execution of Norms	Social Influence and Value Formation; AI-Enabled Sustainable Entrepreneurship	Role of family support; Influence of mentors and industry trends; Peer interaction and entrepreneurial confidence; Development of social responsibility; Formation of technology trust
Practice Transition Pathway: How AI Technology, Policy Support, and Practical Challenges Influence the Transformation of Norms into Entrepreneurial Actions	Practical Challenges in AI Entrepreneurship; Policy and Institutional Support	Business feasibility of AI; Impact of policy incentives on entrepreneurial decision-making; How practical challenges hinder entrepreneurial realization; Challenges in accessing funding; Ethical issues in AI applications

The selective coding analysis not only provides a theoretical framework for understanding the normative development in AI-driven green entrepreneurship but also clarifies the key variables influencing this process. Based on this analysis, five critical variables are identified, and further defined to reveal their role in shaping students' normative development and their engagement in AI-driven green entrepreneurship. These variables span educational empowerment, social influence, AI technology usability, policy support, and practical challenges, collectively influencing students' normative evolution and, ultimately, their entrepreneurial practices.

Among these variables, educational empowerment and norm formation refer to how universities cultivate students' green entrepreneurial awareness and AI adoption mindset through curricula, practical training, and incubation initiatives. Social influence and norm recognition emphasize how external social environments, particularly family, mentors, and industry ecosystems, shape students' attitudes and perceptions of sustainable entrepreneurship. AI technology usability and trust involve students' assessment of AI's practical applications in green entrepreneurship, including its commercialization potential, data analytics capabilities, and market adaptability. Policy support and institutional incentives explore how financial assistance, regulatory frameworks, and industry collaborations enhance students' entrepreneurial confidence. Finally, practical challenges and feasibility examine the role of market acceptance, technological barriers, ethical risks, and access to funding in determining whether normative beliefs translate into actual entrepreneurial activities.

Table 4. Key variables influencing normative development in AI-driven green entrepreneurship.

Variable	Definition
Educational Empowerment and Norm Formation	How universities integrate AI into entrepreneurship education by incorporating AI-powered sustainability courses, intelligent learning systems, and AI-driven startup incubators. AI-based adaptive learning, virtual simulations, and automated feedback systems enhance students' ability to develop AI-driven sustainable business models.
Social Influence and Norm Recognition	How AI-enhanced social networks, digital mentorship platforms, and AI-driven knowledge-sharing environments shape students' subjective norms (SNs) regarding AI-driven green entrepreneurship. AI-powered recommendation systems and industry insights facilitate students' exposure to sustainable AI entrepreneurship role models and peer influences.

Table 4. Continue.

AI Technology Usability and Trust	How students assess AI's capabilities in green entrepreneurship, including AI-driven market intelligence, automated sustainability analytics, and predictive modeling for resource efficiency. The reliability, transparency, and ethical considerations of AI technologies influence students' trust and willingness to adopt AI-powered business solutions.
Policy Support and Institutional Incentives	How AI-related government policies, university-driven AI research initiatives, and institutional AI innovation hubs contribute to fostering AI-driven green entrepreneurship. The effectiveness of AI-focused funding programs, regulatory support for AI sustainability solutions, and AI ethics guidelines impacts students' engagement in sustainable AI startups.
Practical Challenges and Feasibility	How AI-specific barriers—such as algorithmic bias, data security risks, AI infrastructure limitations, and the cost of AI adoption—affect the transition from environmental awareness to AI-driven entrepreneurial action. Overcoming these AI-related constraints is essential for scaling sustainable AI entrepreneurship.

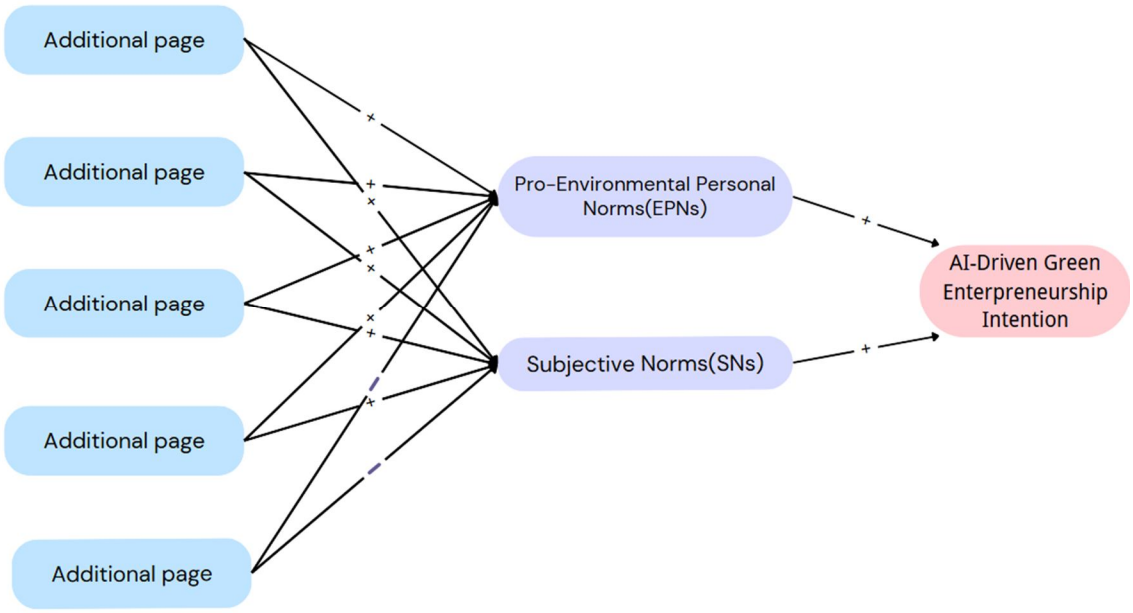

Figure 3. Pathway model of AI-driven factors influencing green entrepreneurship intention through normative development.

Figure 3 illustrates the pathway model of AI-driven factors influencing green entrepreneurship intention through normative development. The model highlights five key factors—educational empowerment, social influence, AI technology usability and trust, policy support and institutional incentives, and practical challenges—that shape students' pro-environmental personal norms (EPNs) and subjective norms (SNs). These norms, in turn, serve as mediators, influencing students' AI-driven green entrepreneurship intention. Educational empowerment and policy support enhance normative formation by providing AI-driven training and institutional backing, while social influence and AI usability impact students' perception and adoption of sustainable entrepreneurial behaviors. Practical challenges act as constraints that may limit the effective transition from normative awareness to entrepreneurial action.

DISCUSSION

This study explores how students in higher education institutions develop pro-environmental personal norms (EPNs) and subjective norms (SNs) within the context of

AI-driven green entrepreneurship. The findings indicate that this development process is shaped through three key pathways: (1) the norm formation pathway, which demonstrates how universities foster students' environmental values and entrepreneurial awareness through AI-driven education, structured curricula, and business incubation programs; (2) the social interaction pathway, which highlights the role of mentors, peers, and industry expectations in shaping students' subjective norms and influencing their green entrepreneurial intentions; and (3) the practice transition pathway, which reveals how AI technology, policy incentives, and practical challenges determine whether students' sustainability awareness translates into entrepreneurial action. These pathways illustrate the interaction between higher education, social influences, and external support mechanisms in shaping students' engagement in AI-driven sustainable entrepreneurship.

The findings show that higher education institutions play a central role in shaping students' pro-environmental personal norms by incorporating AI-powered entrepreneurship education, sustainability-focused curricula, business incubators, and green entrepreneurship initiatives into their academic programs. AI-driven simulations, data analytics tools, and sustainability case studies enhance students' ability to integrate environmental responsibility into entrepreneurial decision-making. Additionally, universities provide structured mentorship programs and facilitate peer interactions, which reinforce students' exposure to sustainable business practices.

Moreover, the results highlight that social influence—including mentorship, peer engagement, and industry expectations—significantly shapes subjective norms and enhances students' motivation to pursue AI-driven green entrepreneurship. Students who receive guidance from faculty members, successful entrepreneurs, and sustainability advocates are more likely to perceive green entrepreneurship as a viable and socially endorsed career path. Peer influence also plays a critical role, as engagement in AI-driven sustainability projects and collaborative entrepreneurial activities fosters shared values and strengthens commitment to sustainable innovation.

Beyond individual and social factors, AI technology and policy support are crucial in transforming students' environmental awareness into concrete entrepreneurial actions. AI applications provide significant advantages in business decision-making, resource efficiency, and sustainable supply chain management, helping students develop scalable and impactful green business models. However, the study also identifies financial constraints, technical challenges, and ethical concerns related to AI adoption as major obstacles that hinder the transition from entrepreneurial intention to action. Many students and early-stage entrepreneurs struggle with the high costs of AI implementation, limited access to AI-driven sustainability tools, and regulatory uncertainties surrounding AI-based entrepreneurship. Without institutional support in the form of funding opportunities, targeted AI training, and policy incentives, students may find it difficult to bridge the gap between sustainability awareness and entrepreneurial execution.

Overall, these findings suggest that while pro-environmental personal norms and subjective norms play a pivotal role in shaping AI-driven green entrepreneurship intentions, the successful realization of these intentions depends on the presence of enabling factors such as AI accessibility, financial resources, and supportive regulatory frameworks. Higher education institutions, industry stakeholders, and policymakers must work together to strengthen AI-driven sustainability education, provide structured mentorship, and reduce barriers to AI adoption in entrepreneurship to ensure that students can effectively translate environmental responsibility into business innovation.

Theoretical implications

This study extends the literature on social norm theory, sustainable entrepreneurship, and AI-enabled education by addressing several critical research gaps. While prior studies have examined the influence of subjective norms on pro-environmental behavior (Batool et al., 2024; Capasso et al., 2025), few have explored the role of higher education in shaping AI-driven green entrepreneurship. This finding aligns with and expands upon the Theory of Planned Behavior (TPB) and the Value-Belief-Norm (VBN) Theory, demonstrating that students' subjective norms are influenced not only by social expectations but also by structured educational interventions and AI technology integration.

Furthermore, while existing research has focused on the role of AI in optimizing sustainable business models and enhancing environmental efficiency (Dash, 2025; Jorzik et al., 2024), this study provides new insights into how AI facilitates norm formation and strengthens students' green entrepreneurial intentions. Additionally, it contributes to the discourse on sustainability education in higher education by demonstrating that AI-driven educational models enhance not only students' entrepreneurial competencies but also the broader institutional culture of green entrepreneurship. These insights provide a novel theoretical perspective on the intersection of AI, education, and sustainability.

Practical implications

The findings offer valuable implications for higher education institutions, policymakers, and businesses in

fostering AI-driven green entrepreneurship.

Higher education institutions should strengthen the integration of AI and sustainable entrepreneurship education by expanding AI-based entrepreneurship courses, providing hands-on AI training, and supporting green business incubation programs. Moreover, interdisciplinary collaboration should be enhanced, integrating AI research with entrepreneurship curricula to equip students with both technical and business skills.

Governments should establish AI-based sustainable entrepreneurship funds, provide tax incentives for green startups, and encourage university-industry collaboration to foster a thriving AI-enabled entrepreneurial ecosystem.

For businesses and investors, the findings highlight the need for resolving technological barriers, ensuring AI ethical compliance, and strengthening industry-academia partnerships. Green startups should focus on enhancing the transparency of AI applications, minimizing algorithmic bias, and lowering the barriers to AI adoption for early-stage entrepreneurs to improve market acceptance and long-term viability.

Conclusion

This study provides a comprehensive analysis of how higher education influences students' pro-environmental personal norms (EPNs) and subjective norms (SNs) in the context of AI-driven green entrepreneurship. This study provides a theoretical framework for understanding how higher education influences the formation of AI-driven sustainable entrepreneurship norms. However, several limitations should be acknowledged. First, the research sample is limited to specific universities and entrepreneurial ecosystems, which may restrict the generalizability of the findings. Future studies should incorporate a more diverse range of institutions and geographical contexts to capture variations in AI adoption and sustainability education. Second, while this study employs qualitative methods to explore students' environmental personal norms and subjective norms, future research could benefit from mixed-method approaches that integrate longitudinal tracking or experimental designs to examine the evolution of these norms over time. Additionally, as AI technologies continue to evolve, their role in green entrepreneurship may shift, necessitating continuous updates to theoretical models. Future studies should investigate how advancements in AI, such as generative AI and blockchain-integrated sustainability solutions, influence entrepreneurial decision-making. Finally, institutional and policy dynamics play a crucial role in shaping AI-driven sustainable entrepreneurship; thus, further research should explore cross-national policy comparisons to identify best practices for integrating AI into sustainability-focused education and entrepreneurship ecosystems. On the other hand, the sample size is relatively small, and the research is confined to a higher education setting, which may limit the generalizability of the findings. Future research should consider expanding the scope of the study by conducting cross-cultural comparisons, longitudinal studies on students' entrepreneurial trajectories, and empirical validation of AI-driven sustainability education outcomes. By deepening our understanding of this subject, both academia and practice can further refine AI-driven sustainable entrepreneurship education models, ultimately fostering innovation and sustainability in the digital era.

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