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Review

Higher education as a driver of green innovation and entrepreneurship: A systematic literature review and future research agenda

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ABSTRACT

This study provides an overview of higher education's impact on promoting green innovation and entrepreneurship through a systematic literature review, adhering to the PRISMA framework. The study synthesizes findings from 47 articles up to 2024, conducting bibliometric and qualitative content analyses. Bibliometric results show that two-thirds of the studies were conducted in Asia, especially China, followed by Europe. Content analysis indicates that green innovation and entrepreneurship contribute to sustainability, with higher education institutions serving as knowledge hubs. Additionally, while green innovation is mainly affected by university-industry collaboration, green entrepreneurship is mainly affected by university support systems. To enhance the impact of higher education, most studies also suggest promoting university support systems for green entrepreneurship and fostering university-industry collaboration for green innovation. A notable research gap is the lack of studies on how higher education influences the translation from green innovation to green entrepreneurship. Based on the identified findings and gaps, the study proposes a future research agenda. Furthermore, universities and companies can benefit from the results and findings of this review in promoting green innovation and green entrepreneurship practices.

1. Introduction

Green innovation (GI) and green entrepreneurship (GE) have been increasingly discussed in recent years as sustainable solutions for the increasing environmental problems. "GI, as defined by Chen et al. (2006), refers to the creation of products, services, or processes that help save energy resources, prevent emissions of toxic air pollutants, and recycle waste materials. GI is considered a key factor not only for addressing environmental problems but also for sustainable social development (Li et al., 2024). Many firms have turned to GI as a business strategy (Takalo and Tooranloo, 2021) because, in addition to improving resource efficiency (Miao et al., 2017; Wang et al., 2017), GI also enable firms to gain competitive advantages (Tu and Wu, 2021; Zhang and Zhu, 2019), and create sustainable economic growth (Ahmed et al., 2022; Sun et al., 2023). GI can be measured in business practices based on technological advancements, eco-friendly production methods, resource efficiency, waste reduction, R&D, patents and licenses, pollution prevention plans, market adoption, and stakeholder cooperation (García-Granero et al., 2018). On the other hand, GE can be defined as the process of exploring, assessing, and exploiting environmentally relevant opportunities neglected by incumbent businesses (Criscuolo and Menon, 2015; Dean and McMullen, 2007). GE plays a vital role in protecting the ecological environment (Makhloufi et al., 2022) as its existence helps adopt and implement new green innovative technologies, services, and processes (Yi, 2021). Additionally, GE plays a mediating role in the relationship between GI and the development of small and medium-sized enterprises (Ebrahimi and Mirbargkar, 2017). Furthermore, GE is considered a valuable tool for creating social and economic impacts that benefit governments in achieving sustainability goals (Neumann, 2022). GE can be measured through innovativeness, growth orientation, international orientation (Neumann, 2023), social responsibility, development potential, R&D investment, environmental protection (Chen et al., 2023), market share, and financial viability (Misztal and Kowalska, 2023). Together, GI and GE are key enablers rooted in the intersection of sustainability dimensions, which aims to balance environmental preservation, economic development, and social well-being. Here, sustainability refers to the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987).

Because of GE's significance in addressing environmental issues,

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more and more countries are becoming entrepreneurial societies and promoting entrepreneurial ecosystems (Paricahua et al., 2022). Nevertheless, many startups face more challenges in running a sustainable business, such as lack of financial resources and information, than traditional businesses (Bergset, 2018; Hoogendoorn et al., 2019). But even incumbent firms also face some problems in implementing GI due to lack of awareness (Zhang et al., 2022). For example, Wee (2022) pointed out in his study that some incumbent businesses tend to use the knowledge gained from GI in non-GI activities, and businesses that actively pursued GI in the past now lack the motivation to produce environmentally friendly innovative technologies in the future. To explain this, Jing (2024) stated that GI is a complicated task, requiring green knowledge, research and development funding, and a clear awareness of future application prospects to put the ideas into actions.

To address the issues arising in the implementation of GI and GE, many studies have explored and confirmed the positive influence of higher education institutions (HEIs) on the perception and implementation of these two concepts. This might be the result of the fact that, with the rise of economic and environmental crises in recent years, HEIs are under pressure to shift from focusing on the traditional dual missions of teaching and research to third mission activities: engagement with industry and society (Compagnucci and Spigarelli, 2020; Guthrie et al., 2024). Through the transfer of knowledge and technology to industry and society, universities involved in third mission activities are increasingly playing a key role in the social, economic, and cultural development of the areas in which they operate (Compagnucci and Spigarelli, 2020). In light of this, these days HEIs' performance is measured not only based on their research impact, or student completion rates (Camilleri, 2021), but also based on third mission activities, i.e., how much regional value HEIs can create to support technology development, innovation and economic growth (Secundo et al., 2023), or how well HEIs improve the sustainability levels of curricula and the campus (Hamdan et al., 2024). These third mission's goals appear to be aligned with GI's goals of promoting green technologies and practices in industries and communities and GE's goals of generating businesses addressing environmental and societal challenges. Along with this line, in their research on university-linked programs for GI and regional development, Wagner et al. (2021) claimed that universities are the key factors in facilitating GE. Additionally, in their study on industry-university-research collaborative innovation, Song et al. (2020) stated that firms should collaborate with universities to advance GI for reducing carbon emissions. Regarding studies on student perspectives, Ramayah et al. (2019) said that HEIs can promote GE intentions among students through academic courses and training programs. In line with this, in their recent research, Ripollés and Blesa (2024) confirmed that environmentally conscious higher education students are increasingly recognized as key actors in adopting GE practices that improve environmental and social conditions at the local and global levels. It can be argued that these examples show the growing interest of scholars in the influence of higher education (HE) on GI and GE intentions and practices. Nevertheless, based on the authors' observations, the concepts of GI and GE were studied separately when considering the impact of HE. Literature review articles related to HEIs' performance, GI, and GE were also found in the literature; however, each concept was independently assessed and the impact of HE on GI and GE was not explicitly addressed. Table 1 presents some of the existing literature review articles on HEIs' performance, GI, and GE along with a summary of their core findings and limitations. Based on these clues, it can be said that no study has yet comprehensively examined the concepts of HE, GI, and GE in an integrated manner. Therefore, this study is conducted to explore how HE impacts GI and GE implementation, and to develop a research agenda for future studies related to these topics. A systematic literature review (SLR) is chosen for the study because according to Petticrew and Roberts (2006), this technique connects a great amount of information and identifies where little or no relevant studies have been carried out in a specific field and where new research is needed.

To achieve the desired objectives, our study aims to answer these research questions.

RQ1. What impact does higher education have on green innovation and green entrepreneurship and what factors drive this impact?

Table 1
A few examples of core findings and limitations from the literature review on higher education, green innovation and entrepreneurship.

Article	Research topic	Core finding	Limitation
Oliveira et al. (2024)	Higher education	- Provided an in-depth analysis of the correlation between co-creation and innovation in HEIs, the transfer of knowledge from HEIs to enterprises, and the impact of the third mission of HEIs on entrepreneurship education. - Contributed to the literature in HEIs, innovation and entrepreneurship.	Did not specify the "green" aspect of innovation and entrepreneurship.
Trevisan et al. (2024)	Higher education	- Explored the role of transformative and organizational learning in enhancing sustainability performance in HE. - Provided theoretical and practical insights into the paths to sustainability in universities.	Did not address the role of GI in advancing sustainability performance in HEIs.
Borsatto and Bazani (2021)	Green innovation	- Examined the factors that promote corporate GI with a focus on environmental regulations. - Contributed to connecting knowledge on the topic of GI.	Did not address the role of knowledge transfer as a relevant factor that promote GI.
Takalo and Tooranloo (2021)	Green innovation	- Highlighted benefits of GI implementation and listed industry sectors applying GI. - Presented a comprehensive study on GI with a significant number of articles included.	Focused mainly on bibliographic characteristics of GI and lacked linkage with HE in promoting implementation.
Araújo and Franco (2021)	Green innovation	- Investigated collaboration networks between organizations towards GI. - Underlined the positive impact that collaboration with universities has on organisational performance.	Did not discover how collaboration between organizations and universities can be enhanced.
Sharma et al. (2020)	Green entrepreneurship	- Provided a conceptual framework comprising research contributions on sustainable entrepreneurship education, in which student mindset and behavior are a key area. - Included and synthesized various aspects related to entrepreneurship.	Did not directly examine the impact of GI education on entrepreneurship.
Hazarika and Zhang (2019)	Green innovation	- Explored theories of GI developed over time in literature. - Mentioned the significance of stakeholders in Gi, including research organizations.	Did not explicitly address the contribution of HE in the development of GI theories or practices.
Demirel et al. (2019)	Green entrepreneurship	- Underscored the factors affecting decision-making and behavior in green start-up ventures, including knowledge spillovers. - Provided a basic understanding of GE.	Did not specifically explore the role of universities in enhancing knowledge spillovers.

RQ2. What direction should future research take to further explore the impact of higher education on promoting green innovation and green entrepreneurship?

This study will contribute to literature as one of the first studies to integrate GI and GE into one assessment in terms of their connection to HE and their link to sustainability. Furthermore, the novelty of this study lies in identifying the university-based drivers for enhancing GI and GE intentions and practices. This may become a valuable reference for scholars identifying research directions, and for HEI policymakers and companies designing programs or projects that facilitate the transformation of GI ideas into GE implementation.

2. Research methodology

To rigorously address the research questions mentioned, this study conducted a SLR, comprising the 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)' and qualitative content analysis approaches. A SLR is a form of evidence synthesis which involves developing eligibility criteria, collecting all available studies that meet these criteria, and summarizing the findings using reproducible procedures that reduce bias and error (Brignardello-Petersen et al., 2025). SLR is the best approach for this research because the extant literature contains a large amount of research related to GI and GE, making it difficult to analyze and synthesize research findings as well as identify research gaps without a comprehensive summary of all available evidence as SLR provides. Qualitative content analysis aims to narrow down events or phenomena by identifying categories to analyze and interpret them more efficiently and concisely (Harwood and Garry, 2003). In this research, the content analysis provides a structured conceptual framework to understand the impact of HE on fostering GI and GE intentions and practices. PRISMA is described as a road map for authors to identify what was done and found in the literature and a checklist for readers to follow the authors' reviewing process (Page et al., 2021). In this study, PRISMA is used as a reporting support tool for the content analysis to leverage the systematic rigor of study selection so that the synthesis of literature findings provides a clear understanding of our research topic. Additionally, the research employed analysis platforms and software, including Rayyan, VOSviewer, and NVivo in screening, coding, analyzing, synthesizing, and interpreting the data collected.

2.1. Keywords and search strings

Primary studies with a cut-off date of October 2024 as the latest study and without a cut-off date as the earliest were selected in an attempt to cover important work extensively via three steps. First, an electronic search in Scopus and Web of Science databases were conducted to ensure that a broad range of scientific output was included. Keywords for search strategies were created, such as 'higher education', 'university', 'green innovation', and 'green entrepreneurship'. Based on these keywords and the extended synonyms of GI and GE identified in the extant literature (e.g. Chavira et al., 2023; Gunawan et al., 2021; Piwowar-Sulej et al., 2021), two search query strings were developed following the Boolean search strategy to seek all relevant studies in the literature. Boolean is a retrieval method combining words with AND, OR, and NOT operators to find documents that best match the query (Lashkari et al., 2009). Because very few studies were found in the literature when combining all keywords into only one search query string, two separate strings were created instead: one to explore the influence of HE on GI and the other to explore the influence of HE on GE, see Table 2. The findings were then filtered out and aggregated during the screening process. The approach of combining the studies found from several search strings has been applied in literature, for example, in the review of languages of origin and education conducted by Alcántara et al. (2023) or in the review of the use of information technologies in supply chain management conducted by Al-Talib et al. (2024). In the next step, following the ancestry approach, also called footnote chasing, introduced by Bates (1990), the references cited in the studies were checked to identify studies that might not be retrieved through database searches due to differences in the terms used in the titles, abstracts, or keywords. This approach was applied because GI and GE each have several synonyms and interpretations; therefore, the search strings created might not cover all relevant studies. This approach has also been used previously in literature (e.g. Jung et al., 2009; Guo et al., 2014; Khalaf et al., 2023) to enhance the comprehensiveness of a systematic literature review.

Table 2
The search query strings used for the literature search.

Database Scopus Web of Science	Search query string
	("higher education" OR "university") AND ("green innovati*" OR "eco-innovati*" OR "ecological innovati*") ("higher education" OR "university") AND ("green entrepreneur*" OR "ecopreneur*" OR "environmental entrepreneur*" OR "enviropreneur*")

2.2. Eligible criteria

In reporting the review, all studies were scanned and only included in the study if they satisfied all the following criteria, see Table 3. First, studies addressing the influence of HE on GI and GE intentions and practices were included, and studies not dealing with this influence were excluded. Second, studies containing in their titles or abstracts the keywords 'student intention', 'higher education', 'green innovation', 'green entrepreneurship' and the extended synonyms of GI and GE were included, and studies not containing these keywords were excluded. Third, studies published up to October 2024 and written in English were included, and studies written in other languages and after the mentioned period were excluded. Furthermore, only empirical studies were included, and literature review articles were excluded with the aim of gaining insights into the research matter from an original perspective. Another important criterion is that peer-reviewed journal articles rated level 1 or higher on Finland's Publication Forum (JUFO) were included, and journal articles not rated as mentioned as well as conference papers and book chapters were excluded. JUFO, established by the Finnish science community, rates publication channels on a four-level scale (1 = basic, 2 = leading, 3 = top, 0 = other) to determine whether peer-

Table 3
Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
- Research field: Studies addressing the impact of higher education on green innovation and entrepreneurship.	- Research field: Studies not dealing with the impact of higher education on green innovation and entrepreneurship.
- Topic: Studies containing in their titles or abstracts the keywords 'higher education', 'university', 'green innovation', and 'green entrepreneurship' and the extended synonyms of green innovation and green entrepreneurship.	- Topic: Studies not containing the keywords mentioned in the inclusion criteria in their titles or abstracts.
- Language: Studies written in English.	- Language: Studies written in other languages.
- Year of publication: Studies published up to October 2024.	- Year of publication: Studies published after October 2024.
- Study design: Empirical studies and not limited to data collection types (e.g., case study, survey).	- Study design: Literature review studies.
- Publication status: Peer-reviewed journal articles ranked level 1 or higher on Finland's Publication Forum (JUFO).	- Publication status: Conference papers, book chapters, and journal articles not ranked level 1 or higher on Finland's Publication Forum (JUFO).

reviewed channels are credible (Pölönen and Auranen, 2022). The JUFO classification was chosen as an indicator of the quality of research output with the aim of including quality studies in this review paper and avoiding so-called grey area journals, which fall into level 0 or even cannot be ranked. Although, to date, no review studies have applied JUFO ranking, some have applied similar journal ranking systems as a criterion in selecting articles with the same purpose of ensuring the inclusion of quality sources. For example, in the review of performance management and measurement impacts on universities, Guthrie et al. (2024) looked for journal articles ranked Q1 and Q2 in the SCImago journal ranking portal. Additionally, in the review of the role of blockchain technologies in anti-corruption practices, Trequattrini et al. (2024) included journal articles ranked from 3* up in the ABS journal ranking list. Moreover, in the review of international studies in banking and finance, Battisti et al. (2021) searched for peer-reviewed journal articles level 3, 4, and 4* also in ABS journal ranking list and stated that it is a common practice in existing systematic literature reviews to develop a quality benchmark for review results.

2.3. Data screening and analysis

The first and the second authors independently conducted initial screening using Rayyan, a web-based and mobile platform for systematic literature reviews (Ouzzani et al., 2016). To avoid influencing each other and ensure reliability, the blind mode was turned on in Rayan so that the authors did not know each other's inclusion and exclusion results. The authors then discussed the differences in the screening results and decided on the list of studies for full-text screening. As stated by Sharma et al. (2020), discussions help to minimize potential bias during data screening. In the full-text screening process, the authors also applied the same procedures as in the initial screening process, including reading and discussion. Moreover, applying the footnote chasing approach in this step, the authors independently checked the references cited in the studies to evaluate their relevance to the objectives of this research. The studies found from this approach were screened and evaluated also based on the eligible criteria to decide which would be included in and excluded from the review, helping reduce bias in selection. When the full-text screening was done, the third author reviewed the list of studies selected to examine their relevance and then discussed it with the first and second authors until the final list was ready for analysis and coding. As a result, of the 2214 articles identified from the databases, 2171 were excluded, and 43 were included. Additionally, of the 8 articles identified through the footnote chasing method, 3 were excluded, and 5 were included. Accordingly, 47 articles were included in this literature review, see Fig. 1. The list of articles included in this review can be found in the supplementary document file.

In the analysis process, firstly bibliometric findings were synthesized and analyzed according to publication years, locations, methodologies, and journals. Besides, based on the linkages between the keywords derived from the included studies using VOSviewer, the findings were divided into four major clusters, see Fig. 2. VOSviewer helps create maps based on co-occurrence, co-authorship and other criteria of network data, especially academic records (Van Eck and Waltman, 2014). This study's co-occurrence map also presents the proportion of GI and GE articles contributing to each cluster. These proportions were calculated by identifying how many of the keywords listed by VOSviewer are from GI and GE articles. If a keyword appeared in both GI and GE articles, it was assigned to both topics and weighted based on the number of articles coming from each topic. When creating the co-occurrence map, the study used a thesaurus file to merge synonyms, for example, 'ecoentrepreneur' and 'green entrepreneurship', or 'sustainable development' and 'sustainability'. The purpose of merging synonyms was to reduce the dispersion of keywords. In addition, since the dataset was relatively small with 113 keywords, a threshold of 1 occurrence was set to ensure that all keywords were included and provide an informative network. Besides, some small clusters were merged by color with the major clusters to improve readability, as according to Bukar et al. (2023), co-occurrence maps serve as a valuable starting point for identifying prominent items and their connections. Bukar et al. (2023) also

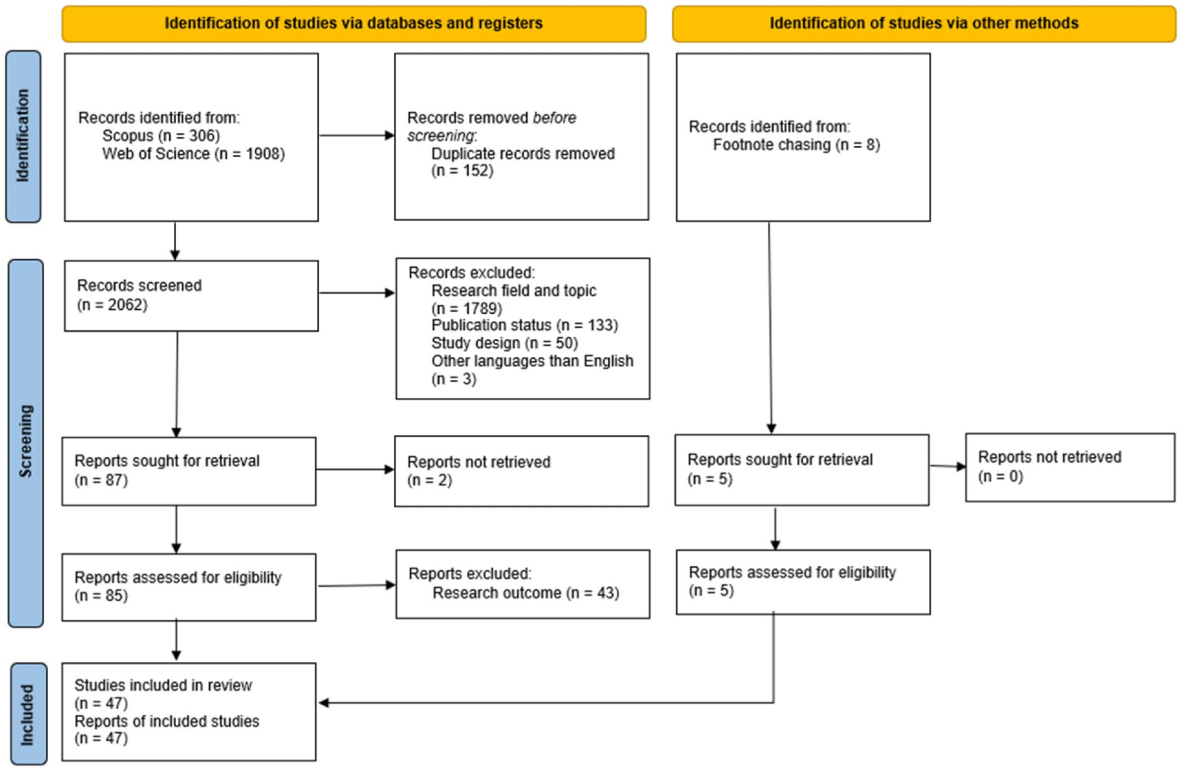

Fig. 1. The PRISMA flow diagram of the literature search process and the number of studies retrieved.

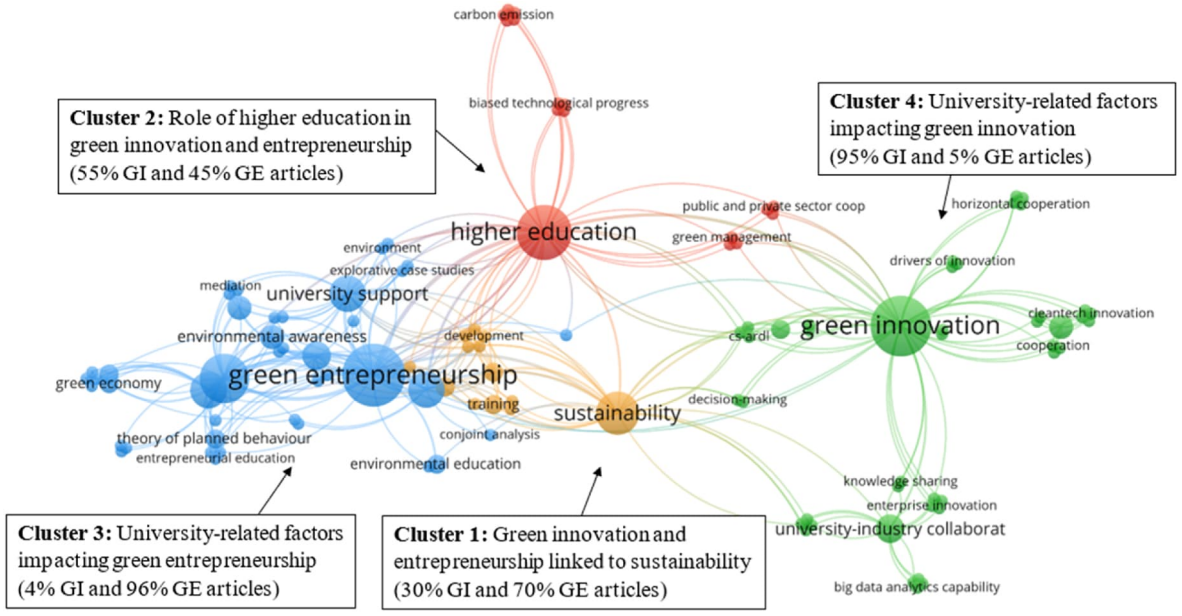

Fig. 2. The major clusters in previous literature regarding higher education, green innovation, green entrepreneurship, and sustainability, as well as the percentage of the GI and GE articles contributing to each cluster (Note: The GI and GE ratios were determined based on the origin of the articles containing the keywords for each cluster.).

highlighed that the content analysis of the data is more important for understanding the strength and direction of the connections, which may be missed when analyzing co-occurrence. The results obtained from the co-occurrence map show that sustainability, in connection with GI and GE, has emerged as one of the four central clusters, although it was not included in the search strings. This is explicable because the literature has proven that GI and GE have close linkages to sustainability (e.g. Aldieri et al., 2020; Gupta and Dharwal, 2022; Mondal, 2023). According to the identified clusters, the first and second authors independently found clues from the studies and started coding using Nvivo software. NVivo software enables users to sort, label, and organize coded data hierarchically through mapping tools and nodes (Dhakal, 2022). The codes assigned by the two authors were then compared and discussed to develop a preliminary coding framework. The third author then reviewed this framework to assess its reliability by comparing it to the coding segments. Although the authors did not conduct inter-coder agreement statistically, but only through debate and consensus, this collaborative process helped ensure a robust coding framework.

3. Bibliographic findings

The bibliometric findings show that the influence of HE on GI and GE have been gaining scholars' attention over the years, see Fig. 3. This increasing attention appears to be aligned with recent studies regarding

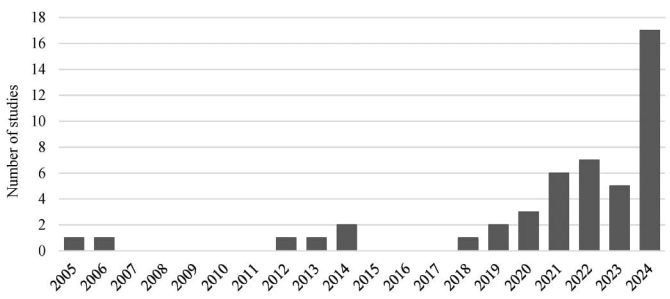

Fig. 3. The number of studies published from 2005 to 2024 on the influence of higher education on green innovation and entrepreneurship intentions and practices.

the role of education in tackling environmental issues for sustainable development (e.g. Blom and Karrow, 2024; Kumar et al., 2024) or in developing workforce knowledge and skills for sustaining economic growth (e.g. Akcigit et al., 2024). The earliest study included in this review was published in 2005. This result aligns with the results of recent literature review studies showing that the concepts of GI and GE have been extensively discussed in the last twenty years or so (e.g., Jiang et al., 2024; Takalo and Tooranloo, 2021). The extension in research has explored various factors and aspects related to GI and GE to enhance their practicality and feasibility, and HE has emerged as a key factor. Serafini et al. (2022) stated in their study that HEIs play a vital role in contributing to an environmentally sustainable, economically viable and socially equitable world. The wider recognition of HE's importance has also led to a significant increase in the number of studies on its impact on GI and GE by 2024, see Fig. 3.

In terms of geographical context, this review represents that China achieved a dominant position when it was selected as the research context of 16 studies, which also contributed greatly to Asia's leading rate among continents with 29 studies, see Fig. 4. Although China has been criticized for being the world's largest consumer of natural resources, it was considered a leader in GI aimed at sustainable development (Urban, 2015). In addition, China's economy and public policies in recent years have also reflected the growing integration of innovation into solving environmental problems (Coussa et al., 2024). Furthermore, many Chinese companies have been already developing GI strategies for their business operations (Guoyou et al., 2013). These demonstrate why China has been frequently chosen as the subject of studies related to the factors that promote GI and GE practices, including the impact of HE. The review also highlights that Europe ranked second with 14 studies, with Germany and Spain sharing the highest number of 4 each. Notably, there were two studies targeting the 27 EU member states as research subjects. Although Europe is well known for its Grean Deal and some of its member states, such as the Nordic countries, Austria and the Netherlands, are known as leaders in sustainable development (Hametner and Kostetckaia, 2020) and in educational innovation (Kirikkaleli et al., 2021), nevertheless the number of studies addressing the influence of HE on GI and GE shown in this review still remained small, and on half that of Asia. Despite this, it was still much higher than America with 5 studies and Africa with only 1 study. The low number of

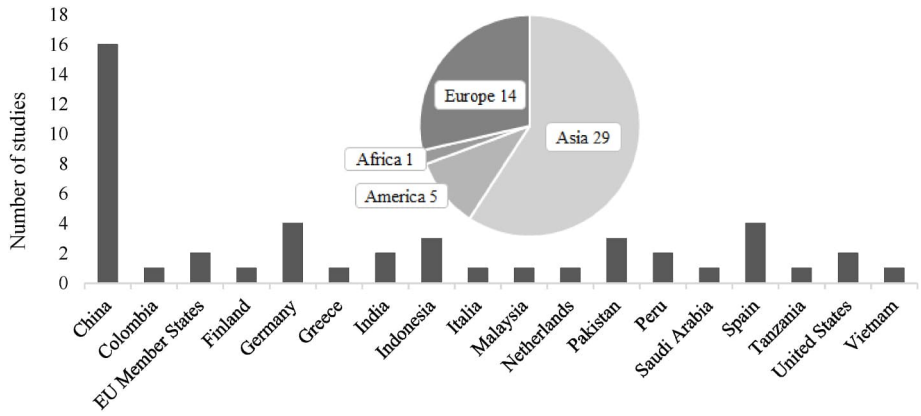

Fig. 4. The countries chosen as research subjects, their respective continents, and the number of studies (Note: This graph shows 49 countries, but the number of studies included is 47 because there are two studies involving two countries each.).

studies targeting these two continents suggests that this research topic is not yet considered a priority there.

In regard to methodologies, it can be noticed that survey was the most popular data collection method with 22 studies, followed by panel data with 7 studies, case study with 6 studies, and others, see Table 4. Most surveys targeted undergraduate and graduate students, as these students are increasingly interested in GE (Yi, 2021) and represent a significant segment of the population of potential entrepreneurs (Neneh, 2019). Furthermore, the study finds that panel data were preferred for GI studies and ranked second with 9 studies. Panel data contains time-varying information and can control the effects of missing or unobserved variables (Hsiao, 2007), allowing for a clear capture of phenomena such as GI (De Marchi et al., 2022). Concerning data analysis, the review shows that quantitative method dominated with 40 studies, followed by qualitative method with 6 studies, and mixed method with 1 study. The quantitative method was used with different approaches, among which partial least square structural equation modeling accounted for the largest share, because according to Qazi et al. (2020) and Waris et al. (2022), it effectively helps confirm the reliability and validity of theories and research data.

In terms of journals, this review shows that Journal of Cleaner Production and The International Journal of Management Education were the most popular journals with 4 studies each, followed by Technological Forecasting and Social Change with 3 studies, see Table 5. Concerning citations, the study finds that Journal of Cleaner Production also remained dominant with 1079 citations. However, the second place went to the Technological Forecasting and Social Change with 322 citations, followed by International Entrepreneurship and Management Journal, with 242 citations. The findings are consistent with Takalo and Tooranloo's (2021) review study on GI that Journal of Cleaner Production is the most popular with the highest number of citations.

Table 4
Research methodologies used in the included studies.

Data collection	No. of articles	Data analysis	No. of articles
Survey	22	Qualitative	6
Case study	6	Quantitative	40
Panel data	9	Mixed method	1
Cross-sectional data	3		
Focus group	1		
Interview	2		
Survey and focus group	1		
Others	3		

Note: Others include contract, publication records, game model.

Table 5
List of journals which have at least 2 studies included in the study and their citations.

Journal	No. of articles	No. of citations
Journal of Cleaner Production	4	1079
The International Journal of Management Education	4	185
Technological Forecasting and Social Change	3	322
Environmental Science and Pollution Research	2	26
Discover Sustainability	2	5
Entrepreneurial Business and Economics Review	2	46
International Entrepreneurship and Management Journal	2	242
Environmental Engineering and Management Journal	2	74
International Journal of Sustainability in Higher Education	2	21

4. Content analysis

In this section, the study analyzes and discusses the main research themes that have existed in the previous literature on GI and GE in relation to HE as well as sustainability. As mentioned in section 2.3, based on the keyword map, this research identified four main clusters from the 47 included studies. During the coding process, these clusters are confirmed as main themes for the review. Additionally, two additional themes related to the enhancement of the impact of HE on GI and GE were developed. These six themes were synthesized into three dimensions, which served as sub-sections of this content analysis, see Fig. 5.

4.1. Foundational knowledge of green innovation, green entrepreneurship, sustainability, and the role of higher education

4.1.1. Green innovation and green entrepreneurship linked to sustainability

Regarding sustainability, the review shows that many studies emphasized the role of GI and GE in generating triple-bottom-line effects, see Table 6. The triple bottom line developed by Elkington (1998) is a framework measuring sustainability across three dimensions: planet, people and profit, i.e. environment, society and economy. In terms of GE, Rafiq et al. (2024) reported that the goal of GE is to keep traditional entrepreneurial values alive and at the same time contribute to financial success, environmental and societal well-being. In line with this report but with a broader perspective, Alshebami et al. (2024) stated that GE can create significant triple-bottom-line effects, but only when the entrepreneurial efforts of institutions align with the environmental, social, and economic dimensions of sustainability. Exploring intentions

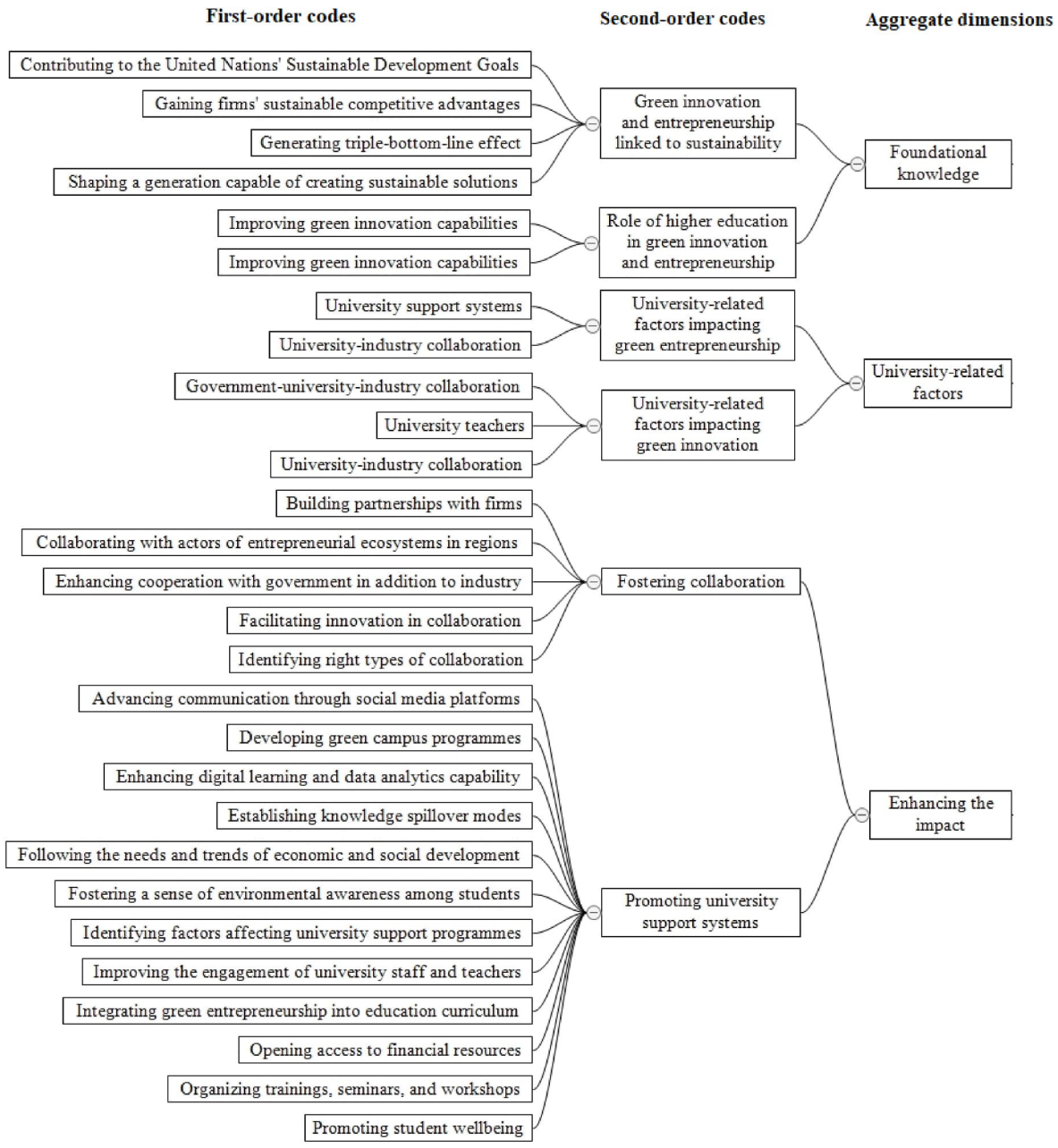

Fig. 5. The coding framework generated from the included studies.

rather than actions, Alfarizi and Herdiansyah (2024) concluded that GE intentions help businesses achieve profits and have a positive influence on the planet and society. Despite the benefits, GE intentions still need an environment in which to be formed and nurtured. Concerning this, campus green projects or GE courses and training programs are reported to contribute to gaining GE intentions with the goal is to achieve the three-dimensional sustainability effects (Andruk and Altinay, 2022; Mehraj et al., 2023). In terms of GI, it is said to help solve environmental issues, such as environmental pollution and resource waste, while promoting economic and social development (He et al., 2021; Sutawaidjaya et al., 2024).

Another aspect discussed in this theme is the contribution of GI and GE in achieving Sustainable Development Goals (SDGs) set by the United Nations, especially SDG number 4, which is a commitment to ensuring quality and equitable education and creating lifelong learning opportunities for all. Specifically, Alvarez-Risco et al. (2021) stated that green ventures run by students with knowledge and skills will contribute to SDGs. However, according to Makuya and Changalima (2024), entrepreneurship education can only help achieve SDG number 4 when gender inequalities does not exist. Regarding the contribution of GI to SGDs, Liu et al. (2024)also emphasized that equipping students with sustainability knowledge will help them acquire GI behavior and lead to the production of green products for sustainable development. In addition to the contribution to SDGs, it is also reported that GI in e-learning or GE education can shape a generation capable of creating sustainable solutions (Alfarizi and Herdiansyah, 2024; Nusraningrum et al., 2024). Besides, GI is also said to help companies achieve sustainable competitive advantages (He et al., 2021) under today's stringent environmental regulations.

4.1.2. Role of higher education in green innovation and green entrepreneurship

This theme includes studies emphasizing the role of HE in improving GI capabilities and fostering GE intention and behavior, see Table 7.

Table 6
The connection between green innovation and green entrepreneurship to sustainability.

Connection to sustainability	GI article	GE article
Generating triple-bottom-line effects	He et al. (2021); Sutawaidjaya et al. (2024)	Alfarizi and Herdiansyah (2024); Alshebami et al. (2024); Andruk and Altinay (2022); Mehraj et al. (2023); Rafiq et al. (2024)
Achieving Sustainable Development Goals	Liu et al. (2024)	Alvarez-Risco et al. (2021); Makuya and Changalima (2024)
Shaping a generation capable of creating sustainable solutions	Nusraningrum et al. (2024)	Alfarizi and Herdiansyah (2024)
Gainging firms' sustainable competitive advantages	He et al. (2021)	

Table 7
The role of higher education in green innovation and green entrepreneurship.

Role of higher education	GI article	GE article
Improving green innovation capabilities	Chang et al. (2023); De Marchi et al. (2022); Di Maria et al. (2019); Jing (2024); Murillo-Luna and Hernández-Trasobares (2023)	
Fostering green entrepreneurial intention and behavior		Alfarizi and Herdiansyah (2024); Alvarez-Risco et al. (2021); Chatterjee et al. (2024); Lans et al. (2014); Paricahua et al. (2022)

Specifically, HEIs were reported by Chang et al. (2023) and De Marchi et al. (2022) provide knowledge and skills to students to contribute to the creation of firms' innovation capabilities. Also confirming the role HEIs in creating and transferring knowledge, but from another perspective, Di Maria et al. (2019) and Jing (2024) emphasized that university-industry collaboration enables firms to build and expand their existing green knowledge through interaction and leads to improvements in their GI capabilities. Murillo-Luna and Hernández-Trasobares (2023) also highlighted the importance of university collaboration with other stakeholders in enhancing GI but focused on the Triple Helix model. The Triple Helix refers to university-industry-government relations, a critical component of innovation strategies (Etzkowitz and Leydesdorff, 1995).

Regarding GE, Lans et al. (2014) stated that HE helps lay the foundation for developing competence for GE. Focusing on the support systems, Chatterjee et al. (2024) emphasized that university entrepreneurial support impacts students' behavior towards GE practices. Besides, Alfarizi and Herdiansyah (2024) argued that HE acts as a catalyst for forming a generation that brings innovative solutions for the environment, and by cooperating with industry, universities help provide knowledge and technologies to entrepreneurs, leading to sustainable development. Furthermore, Alvarez-Risco et al. (2021) indicated that university courses and training programs equip students with the confidence and ability to conduct green ventures, which, as Paricahua et al. (2022) reported, lead to the development of an entrepreneurial ecosystem.

4.2. University-related factors impacting green innovation and green entrepreneurship

4.2.1. Factors impacting green entrepreneurship

This theme includes studies focusing on the impact of university support systems and university-industry collaboration on GE intentions and practices, see Table 8. Regarding university-industry collaboration, studies by Alvarez-Risco et al. (2021) and Kummitha and Kummitha (2021) exploring student GE intentions emphasized that when universities collaborate with companies, they can provide a flow of resources and motivate students to engage in GE. The collaborations can be conducted by building start-up projects or organizing conferences with successful entrepreneurs.

Concerning university support systems, many studies highlighted the contribution of educational support to GE. In this review, educational support can be understood as training activities provided by HEIs to promote enterprises (cf. Alvarez-Risco et al., 2021). In this regard, Waris et al. (2022) indicated that entrepreneurial programs positively influence students' entrepreneurial self-efficacy. Additionally, it was also stated that entrepreneurial training shapes students' attitudes and navigates their behavior towards running green ventures (Alshebami et al., 2024), focusing on green practices (Makuya and Changalima, 2024). In line with this direction but with a somewhat different perspective, Romero-Colmenares and Reyes-Rodríguez (2022) reported that only the curricular aspects of educational support, such as courses, cultivate attitudes for GE because they provide students with relevant knowledge and tools. Besides, Kummitha and Kummitha (2021) reported that students are encouraged to initiate green enterprises from the start of their coursework. Furthermore, sustainability education was argued to have a positive connection to students' GE inclination (Soomro et al., 2020), intention and behavior (Rafiq et al., 2024). Focusing on the influence of environmental courses (Zhang et al., 2024), said that students pursuing such courses have more intention of being green entrepreneurs than those who have not. Chatterjee et al. (2024) also comfirmed that environmental programs foster GI behavior. However, according to Ripollés and Blesa (2024), students' mindset towards GE is indeed impacted by entrepreneurial education teaching methods. With the opposite perspective on education support, the study of Alfarizi and Herdiansyah (2024) indicated that educational support does not positively impact entrepreneurial self-efficacy. It highlighted that their research results differ from other studies on this topic. However, they confirmed that this is caused by the existing general theory and concept-oriented curriculum of the university studied, i.e., the university has not yet integrated the green concept into its entrepreneurship education. Therefore, this research result is insufficient to reject educational support's positive impact on GE intentions and practices.

In addition to educational support, institutional support was also reported to be a factor positively impacting perceptions of GE among students. In this review, institutional support, refers to the university's efforts to provide basic knowledge, guidance, facilities, and other relevant resources to raise GE awareness among students (cf. Alvarez-Risco et al., 2021; Yi, 2021). It was stated that institutional support

Table 8
University-based factors impacting green entrepreneurship.

Factor	GE article
University support systems	Alfarizi and Herdiansyah (2024); Alshebami et al. (2024); Alvarez-Risco et al. (2021); Chatterjee et al. (2024); Kummitha and Kummitha (2021); Makuya and Changalima (2024); Pusparini et al. (2024); Qazi et al. (2020); Rafiq et al. (2024); Ripollés and Blesa (2024); Romero-Colmenares and Reyes-Rodríguez (2022); Soomro et al. (2020); Wagner et al. (2021); Waris et al. (2022); Yang (2024); Yi (2021); Zhang et al. (2024)
University-industry collaboration	Alvarez-Risco et al. (2021); Kummitha and Kummitha (2021)

significantly affects students' entrepreneurial self-efficacy (Alfarizi and Herdiansyah, 2024) and green entrepreneurial behavior (Yang, 2024). More specifically, Pusparini et al. (2024) highlighted that students' personal development is fostered by university facilities, such as courses about environmental awareness or entrepreneurship. Moreover, as emphasized by Yi (2021), both internal and external institutional support of the university play an important role in facilitating the transition from GE intention to GE behavior. When students receive great support from their university, including institutional and curricular aspects (Romero-Colmenares and Reyes-Rodríguez, 2022), it will motivate them to absorb the knowledge values that their university has provided (Qazi et al., 2020). Another type of support that emerged in this theme is technological support, which Alfarizi and Herdiansyah (2024) found to have a positive impact on entrepreneurial self-efficacy. Technology support in this review can be understood as the use of technology as a teaching and learning tool to equip students with the technical skills needed to run green projects (cf. Alfarizi and Herdiansyah, 2024). Also confirming the importance of university support programs as other authors but with a more practical viewpoint, Wagner et al. (2021) underlined that knowledge spillover modes established by universities, such as incubation, will bring positive effects on GE ecosystems.

4.2.2. Factors impacting green innovation

This theme contains research discussing the impact of university-industry collaboration, government-university-industry collaboration, and university teachers, see Table 9. Among these, university-industry collaboration is reported to be a mutually beneficial choice (Yi and Zhang, 2022), the most common type of collaboration (De Marchi et al., 2022), and an important driving force for GI (Triguero et al., 2013) in the context of an increasingly competitive economy (Scarpellini et al., 2012). Explaining this, the studies exploring firms' GI emphasized that, through digital transformation (Tao et al., 2024), such cooperation helps firms access knowledge networks, mitigate risks and costs associated with GI projects, enhance GI capabilities (Jing, 2024; Sáez-Martínez et al., 2014; Xue and Wang, 2024), and have diverse talents and resources (He et al., 2021; Zhang et al., 2022). Besides, targeting university professors as research subjects, Di Maria et al. (2019) highlighted that collaboration with companies provides universities with applied research results that can be translated into publications for wider dissemination of science.

Regarding government-university-industry collaboration, known as the Triple Helix model, it has been reported that the benefits this collaboration brings to companies are higher than those from non-collaborative GI (Li et al., 2024), because environmental regulations and innovation subsidies given by the government to universities and industries help makes R&D greener (Song et al., 2020) and stabilize the GI ecosystem (Li et al., 2024; Yang et al., 2021). Although most studies have applied this collaboration to GI in technical industries, its impact turned it into a global phenomenon in increasing the firms' GI capabilities (Murillo-Luna and Hernández-Trasobares, 2023). Specifying government-university-industry collaboration, Yin et al. (2023) emphasized that the academic workstation platform, connecting universities, enterprises and local governments, is a practical and sustainable approach in promoting GI. In addition to collaborations, Liu et al. (2024) underlined that teachers who are responsible and environmentally oriented play an important role in promoting GI behavior in students.

Table 9
University-based factors impacting green innovation.

Factor	GI article
Government-university-industry collaboration	Li et al. (2024); Murillo-Luna and Hernández-Trasobares (2023); Song et al. (2020); Yang et al. (2021); Yin et al. (2023)
University-industry collaboration	De Marchi et al. (2022); Di Maria et al. (2019); He et al. (2021); Jing (2024); Sáez-Martínez et al. (2014); Scarpellini et al. (2012); Tao et al. (2024); Triguero et al. (2013); Xue and Wang (2024); Yi and Zhang (2022); Zhang et al. (2022)
University teachers	Liu et al. (2024)

4.3. Enhancing the positive impact of higher education on green innovation and entrepreneurship

4.3.1. Fostering collaboration

In this theme, the studies suggested that to enhance the impact of HE on GI and GE, HEIs should build partnerships with firms, enhance collaboration with government in addition to industry, collaborate with actors of entrepreneurial ecosystems in regions, identify right types of collaboration, and facilitate innovation in collaboration, see Table 10. Specifically, from a business perspective, when the knowledge provided by universities is combined with business practices and capabilities, through several mechanisms, such as multi-channel funding (Yi and Zhang, 2022), cost and benefit distribution schemes (Yang et al., 2021), joint research projects (Xue and Wang, 2024), and technology centers (Scarpellini et al., 2012), it will help reduce business costs, benefit both parties and improve GI output (De Marchi et al., 2022; Jing, 2024; Tao et al., 2024). Nevertheless, Liu et al. (2024) suggested that universities should only cooperate with environmentally friendly companies to enhance sustainable practices. Regarding GE, Le et al. (2023) highlighted that universities can organize academic seminars in which successful entrepreneurs are invited to share their experiences to motivate students to run green ventures.

Although developing partnerships with companies is important, it is argued that universities should also strengthen cooperation with governments in developing GI because governments act as an innovation market regulator, adjusting tax rates and providing institutional guarantees for university-industry cooperation (Li et al., 2024; Yang et al., 2021). To strengthen the collaboration between universities, local governments and companies, Yin et al. (2023) proposed the development of academic workstations for facilitating GI and sustaining business strategy formulation. Concerning GE, Koch (2005) stated that universities should seek government support in addition to industry to improve their training programs towards sustainable entrepreneurship, as such collaboration creates a network to spread knowledge and exchange resources (Zhang et al., 2024). Mehraj et al. (2023) also emphasized the need for government support for GE in the tourism

Table 10
Suggestions for fostering collaboration to enhance the impact of higher education on green innovation and green entrepreneurship.

Suggestion	GI article	GE article
Building partnerships with firms	De Marchi et al. (2022); Jing (2024); Liu et al. (2024); Scarpellini et al. (2012); Tao et al. (2024); Xue & Wang (2024); Yang et al. (2021); Yi and Zhang (2022)	Le et al. (2023)
Enhancing collaboration with government in addition to industry	Li et al. (2024); Yang et al. (2021); Yin et al. (2023)	Koch (2005); Mehraj et al. (2023); Zhang et al. (2024)
Collaborating with actors of entrepreneurial ecosystems in regions		Alfarizi and Herdiansyah (2024); Pusparini et al. (2024); Romero-Colmenares and Reyes-Rodríguez (2022)
Indentifying right types of collaboration	Murillo-Luna and Hernández-Trasobares (2023)	Mehraj et al. (2023)
Facilitating collaboration in innovation	Song et al. (2020)	

industry.

In addition to these suggestions, the necessity of collaboration between universities and local stakeholders or surrounding communities is also emphasized in relation to enhancing GE intentions and activities, as these stakeholders can provide students with valuable sources of knowledge and entrepreneurial projects (Alfarizi and Herdiansyah, 2024; Pusparini et al., 2024; Romero-Colmenares and Reyes-Rodríguez, 2022). On the other hand, Murillo-Luna and Hernández-Trasobares (2023) suggested that it is important to consider the type of cooperation in promoting GI, as there are differences between the types of cooperation, influenced by the actors involved. From a different viewpoint, Song et al. (2020) emphasized that collaboration itself needs to apply GI to each process to solve possible problems and avoid adverse impacts.

4.3.2. *Promoting university support systems*

The studies in this theme suggested that to improve the influence on GI and GE, HEIs should strengthen education for sustainable development, promote student wellbeing, organize trainings, seminars, and workshops, open access to financial resources, integrate GE into education curriculum, improve the engagement of university staff and teachers, identify factors affecting university support programs, foster a sense of environmental awareness among students, follow the needs and trends of economic and social development, establish knowledge spillover modes, enhance digital learning and data analytics capability, develop green campus programs, and advance communication through social media, see Table 11.

As can be noticed, the proposal to integrate GE into education curriculum was the most favoured by the authors. It is because by providing students with basic knowledge of green business (Rafiq et al., 2024), GE education is believed to play a critical role in nurturing students' awareness of environmental issues (Alshebami et al., 2024), GE intention (Pusparini et al., 2024), self-efficacy (Alfarizi and Herdiansyah, 2024; Le et al., 2023), and actions (Ripollés and Blesa, 2024), bringing about long-term educational prosperity (Paricahua et al., 2022), and encouraging sustainability (Chatterjee et al., 2024), as GE education system is often built on behavior-oriented practice (Yi, 2021) instead of theoretical teaching provided by traditional entrepreneurship education (Yi, 2021; Zhang et al., 2024). GE education can be designed in the form of entrepreneurship courses (Mehraj et al., 2023; Qazi et al., 2020), training and skill-building workshops (Makuya and Changalima, 2024) and should be consistent with the worldview and values of green entrepreneurs (Renfors, 2019). Furthermore, to achieve environmental, economic, and social aspects of sustainability in education (Waris et al., 2022), it is important to teach students to identify entrepreneurial opportunities (Zampetakis et al., 2006), in addition to fostering their environmental knowledge and concern (Yang, 2024). To teach students such knowledge, Paricahua et al. (2022) and Rafiq et al. (2024) called for the development of sustainability education in HE, which was also the second most popular suggestion featured in our review. Sustainability education was proved to have a positive relationship with GE inclination (Soomro et al., 2020), and be the most important attribute for greening the entrepreneurship curricula (Zampetakis et al., 2006), because it helps students acquire the necessary knowledge and skills for their green projects (Koch, 2005). And when sustainability is applied strategically, it can provide a business advantage for future entrepreneurs (Kummitha and Kummitha, 2021).

The impact of university support for GE is also enhanced by the organization of training courses, seminars, and workshops. These activities are believed to enhance students' green thinking (Alshebami et al., 2024; Yi, 2021) and provide practical knowledge for running green start-ups (Romero-Colmenares and Reyes-Rodríguez, 2022). Nevertheless, such activities cannot be shown to be effective without the participation of university staff and teachers (Fichter and Tiemann, 2018). Therefore, supporting teachers in designing GI curricula (Lans et al., 2014) or providing professional mentors (Yi, 2021) is considered an important task for universities. Ripollés and Blesa (2024) highlighted that an appropriate teaching method helps facilitate the transition from GI ideas to practice. In addition to these supports, students need financial resources to start green businesses, so it is also suggested that universities should provide funding opportunities for students, such as grants and loans (Alfarizi and Herdiansyah, 2024; Makuya and Changalima, 2024; Qazi et al., 2020). Besides, sponsoring GI activities of students is also encouraged (Liu et al., 2024).

Belonging to this theme is also the proposal of establishing knowledge spillover modes, such as incubation centers to promote students' infant GE ideas (Waris et al., 2022; Yang, 2024) and provide talented

Table 11
Suggestions for promoting university support systems to enhance the impact of higher education on green innovation and green entrepreneurship.

Suggestion	GI article	GE article
Advancing communication through social media platforms		Le et al. (2023)
Developing green campus programs	Sutawaidjaya et al. (2024)	Andruk and Altinay (2022)
Enhancing digital learning and data analytics capability	Chang et al. (2023); Nusraningrum et al. (2024); Xue and Wang (2024)	Koch (2005)
Establishing knowledge spillover modes	Zhang et al. (2022)	Waris et al. (2022); Yang (2024); Yi (2021)
Following the needs and trends of economic and social development	Zhou et al. (2024)	Wagner et al. (2021)
Fostering a sense of environmental awareness among students		Zhang et al. (2024)
Identifying factors affecting university support programs		Wagner et al. (2021)
Improving the engagement of university staff and teachers		Fichter and Tiemann (2018); Lans et al. (2014); Ripollés and Blesa (2024); Yi (2021)
Integrating green entrepreneurship into education curriculum		Alfarizi and Herdiansyah (2024); Alshebami et al. (2024); Chatterjee et al. (2024); Le et al. (2023); Makuya and Changalima (2024); Mehraj et al. (2023); Paricahua et al. (2022); Pusparini et al. (2024); Qazi et al. (2020); Rafiq et al. (2024); Renfors (2019); Ripollés & Blesa (2024); Waris et al. (2022); Yang (2024); Yi (2021); Zampetakis et al. (2006), Zhang et al. (2024)
Opening access to financial resources	Liu et al. (2024)	Alfarizi and Herdiansyah (2024); Makuya and Changalima (2024); Qazi et al. (2020)
Organizing training, seminars, and workshops		Alshebami et al. (2024); Qazi et al. (2020); Romero-Colmenares and Reyes-Rodríguez (2022); Yang (2024); Yi (2021)
Promoting student wellbeing	Liu et al. (2024)	Qazi et al. (2020); Yang (2024)
Strengthening education for sustainable development		Koch (2005); Kummitha and Kummitha (2021); Mehraj et al. (2023); Paricahua et al. (2022); Rafiq et al. (2024); Renfors (2019); Soomro et al. (2020); Zampetakis et al. (2006)

human resources to corporate GI (Zhang et al., 2022), or technology industrial parks to facilitate technology transfer from universities to industry (Yi, 2021). However, universities themselves are encouraged to provide technological support to students, especially digital learning, as it helps reduce negative impacts on the environment and enhances positive changes in the GI and GE behavior and practices of both teachers and students (Chang et al., 2023; Koch, 2005; Nusraningrum et al., 2024). Additionally, big data analytics capabilities help drive the impact of industry-academia collaboration on GI (Xue and Wang, 2024). Besides, the implementation of campus greening projects should be added to the list of university strategies (Andruk and Altinay, 2022), as it helps integrate environmental awareness into the three pillars of intellectual activity: education, research and community service (Sutawaidjaya et al., 2024) Another important thing is that universities should follow the economic and social needs and trends (Zhou et al., 2024), especially in their regions, to effectively identify factors affecting their support programs and ensure that their development strategies best fit the regional situation (Wagner et al., 2021).

5. Discussion

This section is divided into three subsections. The first section discusses the bibliographic and content analysis findings and identifies research gaps from the analyzed studies. The second section proposes a future research agenda based on these gaps to guide research directions. The third section presents the limitations of this systematic literature review.

5.1. Bibliographic and content analysis

In terms of bibliographic findings, this review study shows that the number of studies on the impact of HE on GI and GE increased significantly in 2024. However, as can be observed in databases such as Scopus and Web of Science, this number is still very low compared to the number of studies on each concept separately in the same year. Additionally, the review finds that studies conducted in Asia accounted for two-thirds of the included studies, twice as many as studies conducted in Europe. The findings are consistent with the issues addressed by Tolliver et al. (2021) in their study that GI and green finance are increasingly promoted across Asian countries due to the claim that their developing economies have emit more carbon than developed economies. Additionally, as stated by Arici and Uysal (2022), compared to other regions, Asian scholars have focused more on minimizing the negative impacts of industrial development on the environment, with an increasing number of academic publications related to the introduction of environmentally friendly measures in service industries. Although developed countries, especially EU member states, have taken the lead in implementing policies and funding research projects addressing environmental issues (Colombo et al., 2019), the majority of GI initiatives benefit organizations while end users enjoy less than 8 % of the total benefits (Stojčić, 2021). This shortcoming seems insufficient to attract the attention of scholars and policymakers to improving education to promote GI and/or GE, which is reflected in the small number of studies conducted in these advanced economies. Nevertheless, the number of papers conducted in Europe is still nearly three times higher than in the Americas. The results regarding the Americas are aligned with the findings of Filho et al. (2021) that there are a limited number of articles in peer-reviewed journals on sustainable development in the Latin American context due to the fact that the universities in the region face a lack of financial resources, lack of administrative support, and lack of awareness of the importance of sustainability. Studies conducted in Africa remained the lowest among the continents, which is attributed to the fact that African countries have more financial constraints than other developing countries (Abdisa and Hawitibo, 2021), impacting the ability to fund research projects. Additionally, many African universities lack scientific and skill competencies, financial resources, facilities, and equipment (Moshtari and Safarpour, 2024), and some of them do not even have a formally established process for data management (Kabanda et al., 2023), which might negatively affect the motivation of researchers and scientists in conducting research. Another notable thing about the geographical context is the lack of comparison between different economies, such as developing and developed countries, which should have been done to provide a broader and deeper picture of the HE impacts on GI and GE. Concerning research methodologies, this study points out that survey was preferred for collecting data for research on GE, while panel data is preferred for GI. While surveys allow for systematic collection and analysis of data from a defined population (Roberts, 1999), it can be argued that the lack of time-varying information, which can be obtained from panel data, has caused the findings of GE studies to not fully reflect the effectiveness of university support systems or university collaboration in promoting students' GE intentions and behaviors. Furthermore, regarding the research subjects, the majority of GE's research subjects are students, while GI's are existing companies, which has caused some inconsistency in assessing the impact of HE.

In terms of content analysis, this review shows that many included studies focused on proposals to enhance the impact of HE on GI and GE rather than identifying university-based factors influencing GI and GE, or the role of HE in GI and GE, or the contribution of GI and GE to sustainability, see Fig. 6. Regarding the contribution of GI and GE to sustainability, the creation of the triple bottom line effect is the most discussed topic in studies. This finding is consistent with Dixon and Clifford's (2007) finding that GE in the form of green-works is a promising approach for achieving the triple bottom line, and with Larbi-Siaw et al.'s (2022) finding that GI help firms provide a triple bottom line effect, especially under turbulent market conditions. Furthermore, according to Neumann (2022), the involvement of innovation and entrepreneurship in four of the SDGs indicates their importance in sustainable development. Neumann (2022) also emphasized that while GE directly impacts the economy and society, it takes time to see its effect on the environment, especially when GE's activities involve technological innovations. Therefore, to achieve sustainability goals and avoid risks of failure, green entrepreneurs need support with skills training and networking opportunities (Hoogendoorn et al., 2019). This brings up the relevance of HEIs because, regarding their role, HEIs are discussed in the literature in such a way that they act as academic stations for knowledge dissemination to GI and GE. This finding harmonizes with Striukova and Rayna's (2015) study of UK universities that HEIs plays a central role within the open innovation ecosystem in spreading knowledge and promoting collaboration among stakeholders. However, knowledge transfer can encounter many barriers including lack of time, capacity and information to manage relationships and identify partners (Hughes and Kitson, 2012). Such barriers were not addressed in the studies included in this review.

Regarding university-based factors affecting GE, this research indicates that GE is positively influenced by university-industry collaboration, university technical, institutional and educational support systems, and knowledge spillover modes. When examining the role of universities in traditional entrepreneurship, Audretsch (2017) stated that HEIs influence and shape entrepreneurship through technology transfer, knowledge spillover modes, and entrepreneurial capital. This implies that there is harmony in the impact of universities on traditional and green entrepreneurship to a certain extent. Concerning university-based factors affecting GI, this review reports that GI is positively influenced mainly by university-industry collaboration, followed by government-university-industry collaboration, and university faculty and staff. The influence of university-industry collaboration is also emphasized in the study conducted by Un et al. (2010) that R&D collaboration with universities has a positive impact on firm product innovation. In brief, the positive impact of HE on GI and GE has been quite clearly identified in the reviewed studies, however, the problem this paper finds is that university-related factors that hinder GI and GE intentions and practices among students, such as theoretically oriented

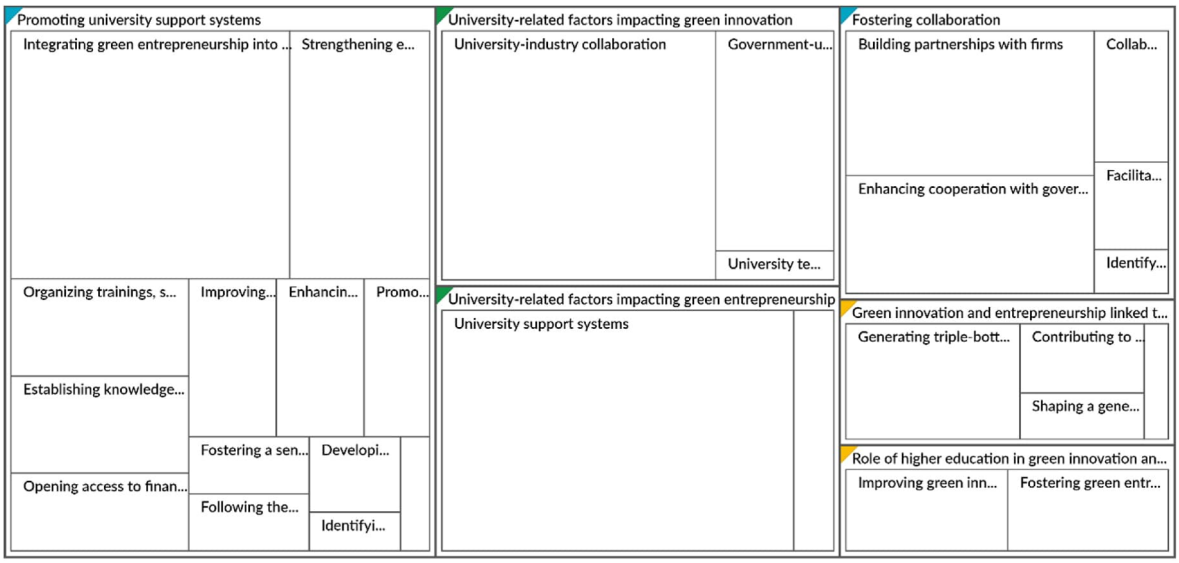

Fig. 6. Hierarchy chart of the themes developed by Nvivo (Note: To read this chart, start from the top-level themes and move down to the nested subthemes. The size of each rectangle represents the relative importance of the theme, with larger sections indicating more prominent themes. For a detailed breakdown of the themes and codes, refer to Fig. 5.).

curricula and lack of financial support, have not been clearly identified. Besides, no studies have evaluated the impact of the Quadruple Helix and Quintuple Helix on GI and GE activities. The Quadruple Helix extends the Triple Helix by adding a media- and culture-based public perspective (Carayannis and Campbell, 2009). From this extension, the Quintuple Helix incorporates the context of the environment, an approach consistent with socioecology and environmental development (Carayannis and Campbell, 2010). Carayannis and Campbell (2021) emphasized that GI and GE should be addressed within these broader themes because without democracy and without environmental and ecological protection, knowledge development and innovation will be severely limited. Moreover, no studies have examined the impact of HE on the transformation of GI ideas into GE activities.

Regarding enhancing the impact of HE on GI and GE, this review shows that the suggestions made for promoting university support systems are much more than for fostering collaboration. In addition, research on GE focused more on university support systems than on collaboration with government and/or industry, and conversely, research on GI focused more on collaboration with government and/or industry than on university support systems. Among the proposals, integrating GE into educational curricula, enhancing sustainability education, and building partnerships with companies were the most frequently suggested. Besides, technological advances such as remote learning and data analytics were also mentioned, but there was no clear idea of artificial intelligence's (AI) involvement while most of the reviewed studies were conducted at a time when AI was already widely used in many fields. When faced with potential transformations that could benefit HE, such as AI, it is important for HEIs to understand them not only from their specificities but also from a more comprehensive understanding of teaching and learning to develop robust educational strategies (Bates et al., 2020).

5.2. *Future research agenda*

Based on the research gaps pointed out in the discussion, this study proposes the research directions shown in Table 12.

Table 12
Research gaps and future research agenda.

	Research gaps	Future research agenda
Geographical context	Lack of studies conducted in the Americas and Africa.	Investigating the impact of HE on GI and/or GE in countries where this topic has not been widely addressed, such as in the Americas and Africa.
	Lack of studies comparing different economies, such as developing and developed countries.	Comparing differences in the involvement of HEIs in promoting students' GI and/or GE intentions and practices in different economies, e.g., developing and developed countries.
Methodology	Lack of time-varying information for research on GE.	Using panel data (or longitudinal data) for examining the long-term effectiveness of HE, including support systems and collaboration, in nurturing GE intentions and practices among students or graduates.
	Lack of interviews with university faculty and staff perceptions of the university's current support system.	Using interviews to explore the opinions of university staff and teachers about their university's support system for promoting GI and GE.
Factor identification	Lack of studies addressing the university-related barriers to GI and GE.	Identifying university-related factors that hinder GI and/or GE intentions and actions among students.
	Lack of studies examining the impact of the Quadruple Helix and Quintuple Helix on GI and GE activities.	Evaluating the impact of the Quadruple Helix and Quintuple Helix on GI and GE activities.
	Lack of studies indentifying the impacts of HE on transforming GI ideas into GE practices.	Determining university-related factors that have positive and negative impacts on the conversion of GI ideas into GE activities.
Impact enhancement	Lack of studies evaluating the use of emerging technologies in advancing university support systems for GI and GE.	Evaluating the role of digital transformation and AI, such as e-learning platforms, virtual assistants and chatbots, and IoT integration, in advancing university support systems for GI and GE.
	Lack of studies examining the impact of knowelege stations in transforming GI ideas into GE practices.	Examining the impact of incubation centers or living labs in transforming GI ideas into GE operations.

5.3. Limitations

Despite the authors' efforts to ensure a comprehensive literature review, this paper cannot avoid limitations. First, because the authors only searched for peer-reviewed articles from two databases, Scopus and Web of Science, along with the ranking criteria of the journals, there are some relevant publications outside these databases and criteria. For example, there are book chapters and conference papers in the literature about the connection between GI, GE, and HE. In grey literature, some reports also emphasize the role of university collaboration in promoting GI. These publications may have similar or different perceptions of the research problem compared to this study. Second, with the main goal of assessing the impact of HE on GI and GE, the authors did not explicitly study the correlation between GI and GE but only put them into an integrated study to gain an insight into the research problem and identify existing research gaps. Therefore, the findings might be less generalizable if the interplay between GI and GE is so significant that changes in one could affect the other, the findings related to HE's impact might be influenced to a certain degree. Third, regarding the connection to sustainability, the study focused much more on reviewing the role of GI and GE in pursuing sustainability goals rather than the opposite direction, for example, how SDGs movitate students to pursue GI and GE. Lastly, the latest articles included in this review were in October 2024, so articles published after this time may provide new perspectives on this research topic.

6. Conclusion

This study aimed to explore the influence of HE on GI and GE towards sustainability and the factors that drive the influence, through a systematic analysis of 47 peer-reviewed journal articles. Regarding the first part of RQ1, the factors affecting GI and GE, the study found that GI is positively affected by university-industry collaboration, followed by government-university-industry collaboration, and then university faculty; and GE is positively affected by university support system, followed by university-industry collaboration. However, the reviewed studies did not explicitly identify the potential negative impact of HEIs on GI and GE and did not examine how HE influences the transition from GI ideation to GE implementation. Regarding the second part of RQ1, enhancing the impact of HE on GI and GE, the study found that the authors of the reviewed studies made more suggestions on promoting university support systems than on promoting collaboration, and the most popular suggestions were integrating GE into educational programs, increasing sustainability education, and building partnerships with companies. Regarding RQ2, the study proposed directions based on the research gaps identified during the analysis and then categorized them into four groups including geographical context, methodology, factor identification, and impact enhancement.

This study has both theoretical and practical implications. In terms of theoretical implications, from the separate studies on the impact of HE on GI and GE, the study has formed a comprehensive framework including the impact factors and the drivers of the impact of HE. This framework will serve as a reference for studies on the impact of HE on GI and GE separately or combined. Another notable contribution is that the study has also identified two main themes in assessing the impact of HE on GI and GE, including the university support system and the cooperation between universities and stakeholders, especially industry and government. Each theme has different drivers and depends on the research object, GE or GI. For example, as mentioned earlier, research on GE focused more on the university support system, while research on GI focused on the university collaboration with stakeholders. Scholars can build on this finding to examine the generalizability of this research trend. In addition, this review also provides brief explanations of the types of university support systems, including educational, institutional, and technical support, which can be used as a classification framework for related research. Moreover, this study also pointed out the link between GI and GE to sustainability, namely, GI and GE help create sustainability and vice versa, education about sustainability will also contribute to promoting GI and GE. Scholars can refer to this correlation to further explore research related to these topics. In terms of practical implications, universities can use the research results as a reference to identify factors affecting students' GI and GE intentions and practices to design appropriate curricula. In addition, through this research, companies can better understand the importance of cooperating with universities in promoting green activities, which benefits not only university students but also companies' GI implementation.

CRediT authorship contribution statement

Phung Nguyen: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Binod Timilsina:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation, Conceptualization. **Ahm Shamsuzzoha:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2025.145820.

Data availability

Data will be made available on request.

References

Abdisa, L.T., Hawitibo, A.L., 2021. Firm performance under financial constraints: evidence from sub-saharan African countries. J. innov. entrepreneurship. 10 (1), 38. https://doi.org/10.1186/s13731-021-00177-1.

Ahmed, F., Kousar, S., Pervaiz, A., Trinidad-Segovia, J.E., del Pilar Casado-Belmonte, M., Ahmed, W., 2022. Role of green innovation, trade and energy to promote green economic growth: a case of South Asian nations. Environ. Sci. Pollut. Control Ser. 29 (5), 6871–6885. https://doi.org/10.1007/s11356-021-15881-4.

Akcigit, U., Pearce, J., Prato, M., 2024. Tapping into talent: coupling education and innovation policies for economic growth. Rev. Econ. Stud. https://doi.org/10.1093/restud/rdae047.

Alcántara, A.C., Sánchez-Martí, A., Rovira, J.P., 2023. Languages of origin and education in Europe: a systematic review. Eur. J. Educ. 58 (1), 151–165. https://doi.org/10.1111/ejed.12537.

Aldieri, L., Kotsemir, M., Vinci, C.P., 2020. The role of environmental innovation through the technological proximity in the implementation of the sustainable development. Bus. Strat. Environ. 29 (2), 493–502. https://doi.org/10.1002/bse.2382.

Alfarizi, M., Herdiansyah, H., 2024. Innate green propensity: precursors of ecopreneurial intentions among Indonesian Education Human Resources University. Int. J. Manag. Educ. 22 (2). https://doi.org/10.1016/j.ijme.2024.100977.

Alshebami, A.S., Fazal, S.A., Seraj, A.H.A., Al Marri, S.H., Alsultan, W.S., 2024. Fostering potential entrepreneurs: an empirical study of the drivers of green self-efficacy in Saudi Arabia. Discover Sustainability 5 (1). https://doi.org/10.1007/s43621-024-00201-w.

Al-Talib, M., Al-Saad, W., Alzoubi, A., Anosike, A.I., 2024. A systematic review of the literature on the use of information technologies in supply chain management. Int. J. Ind. Eng. Oper. Manag. https://doi.org/10.1108/IJIEOM-09-2023-0073.

Alvarez-Risco, A., Mlodzianowska, S., Zamora-Ramos, U., Del-Aguila-Arcentales, S., 2021. Green entrepreneurship intention in university students: the case of Peru. Entrep. Bus. Econ. Rev. 9 (4), 85–100. https://doi.org/10.15678/EBER.2021.090406.

Andruk, C., Altinay, Z., 2022. Campus sustainability in an entrepreneurial framework. J. Small Bus. Enterprise Dev. 29 (3), 484–501. https://doi.org/10.1108/JSBED-01-2021-0023.

Araújo, R., Franco, M., 2021. The use of collaboration networks in search of eco-innovation: a systematic literature review. J. Clean. Prod. 314. https://doi.org/10.1016/j.jclepro.2021.127975.

Arici, H.E., Uysal, M., 2022. Leadership, green innovation, and green creativity: a systematic review. Serv. Ind. J. 42 (5–6), 280–320. https://doi.org/10.1080/02642069.2021.1964482.
Audretsch, D.B., 2017. Entrepreneurship and universities. Int. J. Enterpren. Small Bus. 31 (1), 4. https://doi.org/10.1504/IJESB.2017.10004584.
Bates, M.J., 1990. Where should the person stop and the information search interface start? Inf. Process. Manag. 26 (5), 575–591. https://doi.org/10.1016/0306-4573(90)90103-9.
Bates, T., Cobo, C., Mariño, O., Wheeler, S., 2020. Can artificial intelligence transform higher education? International Journal of Educational Technology in Higher Education 17 (1), 42. https://doi.org/10.1186/s41239-020-00218-x.
Battisti, E., Graziano, E.A., Leonidou, E., Stylianou, I., Pereira, V., 2021. International marketing studies in banking and finance: a comprehensive review and integrative framework. Int. Mark. Rev. 38 (5), 1047–1081. https://doi.org/10.1108/IMR-12-2020-0301.
Bergset, L., 2018. Green start-up finance – where do particular challenges lie? Int. J. Entrepreneurial Behav. Res. 24 (2), 451–575. https://doi.org/10.1108/IJEBR-11-2015-0260.
Blom, R., Karrow, D.D., 2024. Environmental and sustainability education in teacher education research: an international scoping review of the literature. Int. J. Sustain. High Educ. 25 (5), 903–926. https://doi.org/10.1108/IJSHE-07-2023-0288.
Borsatto, J.M.L.S., Bazani, C.L., 2021. Green innovation and environmental regulations: a systematic review of international academic works. Environ. Sci. Pollut. Control Ser. 28 (45), 63751–63768. https://doi.org/10.1007/s11356-020-11379-7.
Brignardello-Petersen, R., Santesso, N., Guyatt, G.H., 2025. Systematic reviews of the literature: an introduction to current methods. Am. J. Epidemiol. 194 (2), 536–542. https://doi.org/10.1093/aje/kwae232.
Brundtland, G.H., 1987. Our common future: report of the World commission on environment and development. Geneva, UN-Dokument A/42/427. http://www.un-documents.net/ocf-ov.htm.
Bukar, U.A., Sayeed, M.S., Razak, S.F.A., Yogarayan, S., Amodu, O.A., Mahmood, R.A.R., 2023. A method for analyzing text using VOSviewer. MethodsX 11, 102339. https://doi.org/10.1016/j.mex.2023.102339.
Camilleri, M.A., 2021. Using the balanced scorecard as a performance management tool in higher education. Manag. Educ. 35 (1), 10–21. https://doi.org/10.1177/0892020620921412.
Carayannis, E.G., Campbell, D.F.J., 2009. “Mode 3” and “Quadruple Helix”: toward a 21st century fractal innovation ecosystem. Int. J. Technol. Manag. 46 (3/4), 201. https://doi.org/10.1504/IJTM.2009.023374.
Carayannis, E.G., Campbell, D.F.J., 2010. Triple Helix, quadruple Helix and quintuple Helix and how do knowledge, innovation and the environment relate to each other? Int. J. Soc. Ecol. Sustain. Dev. 1 (1), 41–69. https://doi.org/10.4018/jsesd.2010010105.
Carayannis, E.G., Campbell, D.F.J., 2021. Democracy of climate and climate for democracy: the evolution of quadruple and quintuple helix innovation systems. J. Knowl. Econ. 12 (4), 2050–2082. https://doi.org/10.1007/s13132-021-00778-x.
Chang, J., Li, B., Chen, B., Shen, Y., Lv, X., Liu, J., 2023. Does higher education promote sustainable development? Role of green technology and financial performance. Environ. Sci. Pollut. Control Ser. 30 (41), 94890–94903. https://doi.org/10.1007/s11356-023-28927-6.
Chatterjee, R.S., Khan, N.R., Hameed, I., Waris, I., 2024. Exploring the relationship between student green engagement and entrepreneurial behavior: a serial mediation approach. Global Knowledge, Memory and Communication. https://doi.org/10.1108/GKMC-10-2023-0375.
Chavira, P.C., Shamsuzzoha, A., Kuusniemi, H., Jovanovski, B., 2023. Defining green innovation, its impact, and cycle – a literature analysis. Clean. Eng. Technol. 17, 100693. https://doi.org/10.1016/j.clet.2023.100693.
Chen, S., Shen, W., Qiu, Z., Liu, R., Mardani, A., 2023. Who are the green entrepreneurs in China? The relationship between entrepreneurs’ characteristics, green entrepreneurship orientation, and corporate financial performance. J. Bus. Res. 165, 113960. https://doi.org/10.1016/j.jbusres.2023.113960.
Chen, Y.-S., Lai, S.-B., Wen, C.-T., 2006. The influence of green innovation performance on corporate advantage in Taiwan. J. Bus. Ethics 67 (4), 331–339. https://doi.org/10.1007/s10551-006-9025-5.
Colombo, L.A., Pansera, M., Owen, R., 2019. The discourse of eco-innovation in the European Union: an analysis of the eco-innovation action plan and Horizon 2020. J. Clean. Prod. 214, 653–665. https://doi.org/10.1016/j.jclepro.2018.12.150.
Compagnucci, L., Spigarelli, F., 2020. The third mission of the university: a systematic literature review on potentials and constraints. Technol. Forecast. Soc. Change 161, 120284. https://doi.org/10.1016/j.techfore.2020.120284.
Coussa, A., Gugler, P., Reidy, J., 2024. Assessing the development of green innovation in China through patent evolution: the hallmark of government policy and private enterprises. Int. J. Emerg. Mark. https://doi.org/10.1108/IJOEM-09-2023-1512.
Criscuolo, C., Menon, C., 2015. Environmental policies and risk finance in the green sector: cross-country evidence. Energy Policy 83, 38–56. https://doi.org/10.1016/j.enpol.2015.03.023.
De Marchi, V., Molina-Morales, F.X., Martínez-Cháfer, L., 2022. Environmental innovation and cooperation: a configurational approach. Technol. Forecast. Soc. Change 182. https://doi.org/10.1016/j.techfore.2022.121835.
Dean, T.J., McMullen, J.S., 2007. Toward a theory of sustainable entrepreneurship: reducing environmental degradation through entrepreneurial action. J. Bus. Ventur. 22 (1), 50–76. https://doi.org/10.1016/j.jbusvent.2005.09.003.
Demirel, P., Li, Q.C., Rentocchini, F., Tamvada, J.P., 2019. Born to be green: new insights into the economics and management of green entrepreneurship. Small Bus. Econ. 52 (4), 759–771. https://doi.org/10.1007/s11187-017-9933-z.
Dhakal, K., 2022. NVivo. J. Med. Libr. Assoc. 110 (2). https://doi.org/10.5195/jmla.2022.1271.
Di Maria, E., De Marchi, V., Spraul, K., 2019. Who benefits from university–industry collaboration for environmental sustainability? Int. J. Sustain. High Educ. 20 (6), 1022–1041. https://doi.org/10.1108/IJSHE-10-2018-0172.
Dixon, S.E.A., Clifford, A., 2007. Ecopreneurship – a new approach to managing the triple bottom line. J. Organ. Change Manag. 20 (3), 326–345. https://doi.org/10.1108/09534810710740164.
Ebrahimi, P., Mirbargkar, S.M., 2017. Green entrepreneurship and green innovation for SME development in market turbulence. Eurasian Bus. Rev. 7 (2), 203–228. https://doi.org/10.1007/s40821-017-0073-9.
Elkington, J., 1998. Cannibals with Forks: the Triple Bottom Line of 21st Century Business. New Society Publishers.
Etzkowitz, H., Leydesdorff, L., 1995. The triple Helix—University-Industry-Government relations: a laboratory for knowledge-based economic development. EASST Review 14, 14–19.
Fichter, K., Tiemann, I., 2018. Factors influencing university support for sustainable entrepreneurship: insights from explorative case studies. J. Clean. Prod. 175, 512–524. https://doi.org/10.1016/j.jclepro.2017.12.031.
Filho, W.L., Amaro, N., Avila, L.V., Brandli, L., Damke, L.I., Vasconcelos, C.R.P., Hernandez-Diaz, P.M., Frankenberger, F., Fritzen, B., Velazquez, L., Salvia, A., 2021. Mapping sustainability initiatives in higher education institutions in Latin America. J. Clean. Prod. 315, 128093. https://doi.org/10.1016/j.jclepro.2021.128093.
García-Granero, E.M., Piedra-Muñoz, L., Galdeano-Gómez, E., 2018. Eco-innovation measurement: a review of firm performance indicators. J. Clean. Prod. 191, 304–317. https://doi.org/10.1016/j.jclepro.2018.04.215.
Gunawan, A.A., van Riel, A.A., Essers, C., 2021. What drives ecopreneurship in women and men? - a structured literature review. J. Clean. Prod. 280, 124336. https://doi.org/10.1016/j.jclepro.2020.124336.
Guo, J., Tsai, Y., Liao, J., Tu, H., Huang, C., 2014. Interventions to reduce the number of falls among older adults with/without cognitive impairment: an exploratory meta-analysis. Int. J. Geriatr. Psychiatr. 29 (7), 661–669. https://doi.org/10.1002/gps.4056.
Guoyou, Q., Saixing, Z., Chiming, T., Haitao, Y., Hailiang, Z., 2013. Stakeholders’ influences on corporate green innovation strategy: a case study of manufacturing firms in China. Corp. Soc. Responsib. Environ. Manag. 20 (1), 1–14. https://doi.org/10.1002/csr.283.
Gupta, M., Dharwal, M., 2022. Green entrepreneurship and sustainable development: a conceptual framework. Mater. Today Proc. 49, 3603–3606. https://doi.org/10.1016/j.matpr.2021.08.148.
Guthrie, J., Manes-Rossi, F., Orelli, R.L., Sforza, V., 2024. Performance management and measurement impacts on universities: (re)viewing the past, present and future. J. Public Budg. Account. Financ. Manag. 36 (6), 1–25. https://doi.org/10.1108/JPBAFM-10-2023-0176. Emerald Publishing.
Hamdan, A., Hamdan, S., Alsyouf, I., Murad, N., Abdelrazeq, M., Al-Ali, S., Bettayeb, M., 2024. Enhancing sustainability performance of universities: a DMAIC approach. Syst. Res. Behav. Sci. 41 (1), 153–172. https://doi.org/10.1002/sres.2942.
Hametner, M., Kostetckaia, M., 2020. Frontrunners and laggards: how fast are the EU member states progressing towards the sustainable development goals? Ecol. Econ. 177, 106775. https://doi.org/10.1016/j.ecolecon.2020.106775.
Harwood, T.G., Garry, T., 2003. An overview of content analysis. Market. Rev. 3 (4), 479–498. https://doi.org/10.1362/146934703771910080.
Hazarika, N., Zhang, X., 2019. Evolving theories of eco-innovation: a systematic review. Sustain. Prod. Consum. 19, 64–78. https://doi.org/10.1016/j.spc.2019.03.002. Elsevier B.V.
He, K., Chen, W., Zhang, L., 2021. Senior management’s academic experience and corporate green innovation. Technol. Forecast. Soc. Change 166. https://doi.org/10.1016/j.techfore.2021.120664.
Hoogendoorn, B., van der Zwan, P., Thurik, R., 2019. Sustainable entrepreneurship: the role of perceived barriers and risk. J. Bus. Ethics 157 (4), 1133–1154. https://doi.org/10.1007/s10551-017-3646-8.
Hsiao, C., 2007. Panel data analysis—advantages and challenges. TEST 16 (1), 1–22. https://doi.org/10.1007/s11749-007-0046-x.
Hughes, A., Kitson, M., 2012. Pathways to impact and the strategic role of universities: new evidence on the breadth and depth of university knowledge exchange in the UK and the factors constraining its development. Camb. J. Econ. 36 (3), 723–750. https://doi.org/10.1093/cje/bes017.
Jiang, Z., Xu, Y., Zhu, X., Liu, W., Liu, Y., 2024. Intellectual capital and green entrepreneurship: a systematic literature review. J. Intellect. Cap. 25 (4), 801–821. https://doi.org/10.1108/JIC-12-2023-0287.
Jing, L.C., 2024. How does university-industry collaboration drives the green innovation? Sage Open 14 (3). https://doi.org/10.1177/21582440241274500.
Jung, D., Lee, J., Lee, S.M., 2009. A meta-analysis of fear of falling treatment programs for the elderly. West. J. Nurs. Res. 31 (1), 6–16. https://doi.org/10.1177/0193945908320466.
Kabanda, S.M., Cengiz, N., Rajaratnam, K., Watson, B.W., Brown, Q., Esterhuizen, T.M., Moodley, K., 2023. Data sharing and data governance in Sub-Saharan Africa: perspectives from researchers and scientists engaged in data-intensive research. South Afr. J. Sci. 119 (5/6). https://doi.org/10.17159/sajs.2023/15129.
Khalaf, A.M., Alubied, A.A., Khalaf, A.M., Rifaey, A.A., 2023. The impact of social media on the mental health of adolescents and young adults: a systematic review. Cureus. https://doi.org/10.7759/cureus.42990.
Kirikkaleli, D., Ertugrul, H.M., Sari, A., Ozun, A., Kiral, H., 2021. Quality of education and technological readiness: Bootstrap panel causality analysis for Northern European countries. Scand. J. Educ. Res. 65 (2), 276–287. https://doi.org/10.1080/00313831.2019.1705892.

Koch, A.H., 2005. An analysis of training and promotion of entrepreneurship in sustainability management. Int. J. Sustain. High Educ. 6 (2), 114–121. https://doi.org/10.1108/14676370510589837.
Kumar, V., Choudhary, S.K., Singh, R., 2024. Environmental socio-scientific issues as contexts in developing scientific literacy in science education: a systematic literature review. Soc. Sci. Humanit. Open 9, 100765. https://doi.org/10.1016/j.ssaho.2023.100765.
Kummitha, H.R., Kummitha, R.K.R., 2021. Sustainable entrepreneurship training: a study of motivational factors. Int. J. Manag. Educ. 19 (1). https://doi.org/10.1016/j.ijme.2020.100449.
Lans, T., Blok, V., Wesselink, R., 2014. Learning apart and together: towards an integrated competence framework for sustainable entrepreneurship in higher education. J. Clean. Prod. 62, 37–47. https://doi.org/10.1016/j.jclepro.2013.03.036.
Larbi-Siaw, O., Xuhua, H., Owusu, E., Owusu-Agyeman, A., Fulgence, B.E., Frimpong, S. A., 2022. Eco-innovation, sustainable business performance and market turbulence moderation in emerging economies. Technol. Soc. 68, 101899. https://doi.org/10.1016/j.techsoc.2022.101899.
Lashkari, A.H., Mahdavi, F., Ghomi, V., 2009. A boolean model in information retrieval for search engines. In: 2009 International Conference on Information Management and Engineering, pp. 385–389. https://doi.org/10.1109/ICIME.2009.101.
Le, T.N.P., Nguyen, K.H., Nguyen, N.T.H., 2023. How environmental understanding affects the green entrepreneurial intention of centennials in Vietnam. Entrep. Bus. Econ. Rev. 11 (4), 123–137. https://doi.org/10.15678/EBER.2023.110408.
Li, Y., Zhenhong, X., Fu, Z., Wu, Y., Wang, Y., 2024. Green technology innovation models, environmental regulation and the willingness of government-university-industry to collaborate on green innovation. Energy Rep. 12, 2901–2912. https://doi.org/10.1016/j.egyr.2024.08.031.
Liu, J., Wen, H., Wen, R., Zhang, W., Cui, Y., Wang, H., 2024. Influence mechanism of undergraduate students' green innovation behavior: AMO perspective and multilevel empirical study. Int. J. Sustain. High Educ. https://doi.org/10.1108/IJSHE-02-2023-0067.
Makhloufi, L., Laghouag, A.A., Meirun, T., Belaid, F., 2022. Impact of green entrepreneurship orientation on environmental performance: the natural resource-based view and environmental policy perspective. Bus. Strat. Environ. 31 (1), 425–444. https://doi.org/10.1002/bse.2902.
Makuya, V., Changalima, I.A., 2024. Unveiling the role of entrepreneurship education on green entrepreneurial intentions among business students: gender as a moderator. Cogent Educ. 11 (1). https://doi.org/10.1080/2331186X.2024.2334585.
Mehraj, D., Ul Islam, M.I., Qureshi, I.H., Basheer, S., Baba, M.M., Nissa, V.u., Asif Shah, M., 2023. Factors affecting entrepreneurial intention for sustainable tourism among the students of higher education institutions. Cogent Bus. Manag. 10 (3). https://doi.org/10.1080/23311975.2023.2256484. Cogent OA.
Miao, C., Fang, D., Sun, L., Luo, Q., 2017. Natural resources utilization efficiency under the influence of green technological innovation. Resour. Conserv. Recycl. 126, 153–161. https://doi.org/10.1016/j.resconrec.2017.07.019.
Misztal, A., Kowalska, M., 2023. Factors of green entrepreneurship in selected emerging markets in the European Union. Environ. Dev. Sustain. 26 (11), 28269–28292. https://doi.org/10.1007/s10668-023-03811-y.
Mondal, S., 2023. The Nexus between green entrepreneurship and sustainable development: an econometric study. Glob. Bus. Rev. https://doi.org/10.1177/09721509231157009.
Moshtari, M., Safarpour, A., 2024. Challenges and strategies for the internationalization of higher education in low-income East African countries. High. Educ. 87 (1), 89–109. https://doi.org/10.1007/s10734-023-00994-1.
Murillo-Luna, J.L., Hernández-Trasobares, A., 2023. Cooperation with the Triple Helix and corporate environmental innovation. J. Clean. Prod. 384. https://doi.org/10.1016/j.jclepro.2022.135479.
Neneh, B.N., 2019. From entrepreneurial alertness to entrepreneurial behavior: the role of trait competitiveness and proactive personality. Pers. Indiv. Differ. 138, 273–279. https://doi.org/10.1016/j.paid.2018.10.020.
Neumann, T., 2022. Impact of green entrepreneurship on sustainable development: an ex-post empirical analysis. J. Clean. Prod. 377, 134317. https://doi.org/10.1016/j.jclepro.2022.134317.
Neumann, T., 2023. Are greener start-ups of superior quality? The impact of environmental orientation on innovativeness, growth orientation, and international orientation. J. innov. entrepreneurship. 12 (1). https://doi.org/10.1186/s13731-023-00330-y.
Nusraningrum, D., Widyanti, W., Indrajaya, S., Soonsan, N., Sangthong, S., Pattanapokinsakul, K., 2024. Improving E-learning mediating green innovation and green technology for green management practice. Discover Sustainability 5 (1). https://doi.org/10.1007/s43621-024-00463-4.
Oliveira, T., Alves, H., Leitão, J., 2024. Co-creation and innovation in higher education institutions: a systematic literature review and research agenda. Int. J. Educ. Manag. 38 (3), 839–872. https://doi.org/10.1108/IJEM-09-2023-0456. Emerald Publishing.
Ouzzani, M., Hammady, H., Fedorowicz, Z., Elmagarmid, A., 2016. Rayyan—A web and mobile app for systematic reviews. Syst. Rev. 5 (1), 210. https://doi.org/10.1186/s13643-016-0384-4.
Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., McDonald, S., et al., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ n71. https://doi.org/10.1136/bmj.n71.
Paricahua, E.W.P., Padilla, J.M.C., Madrid, S.D.P.C., Tarazona, J.O.G., Muñoz, S.A.S., Acevedo, J.E.R., et al., 2022. The mediating role of the entrepreneurial ecosystem in the entrepreneurial personality and green entrepreneurship: the case of Peruvian's university students. AgBioforum 24 (3). https://hdl.handle.net/10355/94691.
Petticrew, M., Roberts, H., 2006. How to appraise the studies: an introduction to assessing study quality. In: Systematic Reviews in the Social Sciences. Wiley, pp. 125–163. https://doi.org/10.1002/9780470754887.ch5.
Piwowar-Sulej, K., Krzywonos, M., Kwil, I., 2021. Environmental entrepreneurship – bibliometric and content analysis of the subject literature based on H-Core. J. Clean. Prod. 295, 126277. https://doi.org/10.1016/j.jclepro.2021.126277.
Pölönen, J., Auranen, O., 2022. Research performance and scholarly communication profile of competitive research funding: the case of Academy of Finland. Scientometrics 127 (12), 7415–7433. https://doi.org/10.1007/s11192-022-04385-8.
Pusparini, M.D., Bonang, D., Virgiawan, R., Sukmana, R., Lahuri, S. bin, Fedro, A., 2024. Does religiosity affect green entrepreneurial intention? Case study in Indonesia. J. Islam. Mark. https://doi.org/10.1108/JIMA-12-2023-0419.
Qazi, W., Qureshi, J.A., Raza, S.A., Khan, K.A., Qureshi, M.A., 2020. Impact of personality traits and university green entrepreneurial support on students' green entrepreneurial intentions: the moderating role of environmental values. J. Appl. Res. High Educ. https://doi.org/10.1108/JARHE-05-2020-0130.
Rafiq, M., Yang, J., Bashar, S., 2024. Impact of personality traits and sustainability education on green entrepreneurship behavior of university students: mediating role of green entrepreneurial intention. J. glob. entrep. res. 14 (1). https://doi.org/10.1007/s40497-024-00384-6.
Ramayah, T., Rahman, S.A., Taghizadeh, S.K., 2019. Modelling green entrepreneurial intention among university students using the entrepreneurial event and cultural values theory. Int. J. Entrepreneurial Ventur. 11 (4), 394–412. https://doi.org/10.1504/IJEV.2019.101629.
Renfors, S.M., 2019. Identification of ecopreneurs' business competencies for training program development. J. Educ. Bus. https://doi.org/10.1080/08832323.2019.1595501.
Ripollés, M., Blesa, A., 2024. The role of teaching methods and students' learning motivation in turning an environmental mindset into entrepreneurial actions. Int. J. Manag. Educ. 22 (2). https://doi.org/10.1016/j.ijme.2024.100961.
Roberts, E.S., 1999. In defence of the survey method: an illustration from a study of user information satisfaction. Account. Finance 39 (1), 53–77. https://doi.org/10.1111/1467-629X.00017.
Romero-Colmenares, L.M., Reyes-Rodríguez, J.F., 2022. Sustainable entrepreneurial intentions: exploration of a model based on the theory of planned behaviour among university students in north-east Colombia. Int. J. Manag. Educ. 20 (2). https://doi.org/10.1016/j.ijme.2022.100627.
Sáez-Martínez, F.J., González-Moreno, A., Hogan, T., 2014. The role of the university in Eco-Entrepreneurship: evidence from the Eurobarometer survey on attitudes of European entrepreneurs towards eco-innovation. Environ. Eng. Manag. J. https://doi.org/10.30638/eemj.2014.284.
Scarpellini, S., Aranda, A., Aranda, J., Llera, E., Marco, M., 2012. R&D and eco-innovation: opportunities for closer collaboration between universities and companies through technology centers. Clean Technol. Environ. Policy 14 (6), 1047–1058. https://doi.org/10.1007/s10098-012-0514-1.
Secundo, G., Lombardi, R., Dumay, J., Guthrie, A.M.J., 2023. Reflecting on intellectual capital measurement and management in European universities. Meditari Account. Res. 31 (6), 1827–1845. https://doi.org/10.1108/MEDAR-03-2022-1632.
Serafini, P.G., Moura, J. M. de, Almeida, M. R. de, Rezende, J. F. D. de, 2022. Sustainable development goals in higher education institutions: a systematic literature review. J. Clean. Prod. 370, 133473. https://doi.org/10.1016/j.jclepro.2022.133473.
Sharma, S., Goyal, D.P., Singh, A., 2020. Systematic review on sustainable entrepreneurship education (SEE): a framework and analysis. World Journal of Entrepreneurship, Management and Sustainable Development. https://doi.org/10.1108/WJEMSD-05-2020-0040. *ahead-of-print*(ahead-of-print).
Song, Y., Zhang, J., Song, Y., Fan, X., Zhu, Y., Zhang, C., 2020. Can industry-university-research collaborative innovation efficiency reduce carbon emissions? Technol. Forecast. Soc. Change 157. https://doi.org/10.1016/j.techfore.2020.120094.
Soomro, B.A., Ghumro, I.A., Shah, N., 2020. Green entrepreneurship inclination among the younger generation: an avenue towards a green economy. Sustain. Dev. (Bradf.) 28 (4), 585–594. https://doi.org/10.1002/sd.2010.
Stojčić, N., 2021. Social and private outcomes of green innovation incentives in European advancing economies. Technovation 104, 102270. https://doi.org/10.1016/j.technovation.2021.102270.
Striukova, L., Rayna, T., 2015. University-industry knowledge exchange: an exploratory study of open innovation in UK universities. Eur. J. Innovat. Manag. 18 (4), 471–492. https://doi.org/10.1108/EJIM-10-2013-0098.
Sun, Y., Gao, P., Tian, W., Guan, W., 2023. Green innovation for resource efficiency and sustainability: empirical analysis and policy. Resour. Policy 81. https://doi.org/10.1016/j.resourpol.2023.103369.
Sutawaidjaya, A.H., Yusuf, M., Hamdi, E., 2024. Building sustainability in higher education through green management and innovation: a case study of private universities in Jakarta. J. Ecohumanism. 3 (6), 1034–1047. https://doi.org/10.62754/joe.v3i6.4071.
Takalo, S.K., Tooranloo, H.S., 2021. Green innovation: a systematic literature review. J. Clean. Prod. 279. https://doi.org/10.1016/j.jclepro.2020.122474. Elsevier Ltd.
Tao, A., Wang, C., Zhang, S., Kuai, P., 2024. Does enterprise digital transformation contribute to green innovation? micro-level evidence from China. J. Environ. Manag. 370, 122609. https://doi.org/10.1016/j.jenvman.2024.122609.
Tolliver, C., Fujii, H., Keeley, A.R., Managi, S., 2021. Green innovation and finance in Asia. Asian Econ. Policy Rev. 16 (1), 67–87. https://doi.org/10.1111/aepr.12320.

Trequattrini, R., Palmaccio, M., Turco, M., Manzari, A., 2024. The contribution of blockchain technologies to anti-corruption practices: a systematic literature review. Bus. Strat. Environ. 33 (1), 4–18. https://doi.org/10.1002/bse.3327.

Trevisan, L.V., Leal Filho, W., Pedrozo, E.Á., 2024. Transformative organisational learning for sustainability in higher education: a literature review and an international multi-case study. J. Clean. Prod. 447. https://doi.org/10.1016/j.jclepro.2024.141634.

Triguero, A., Moreno-Mondéjar, L., Davia, M.A., 2013. Drivers of different types of eco-innovation in European SMEs. Ecol. Econ. 92, 25–33. https://doi.org/10.1016/j.ecolecon.2013.04.009.

Tu, Y., Wu, W., 2021. How does green innovation improve enterprises' competitive advantage? The role of organizational learning. Sustain. Prod. Consum. 26, 504–516. https://doi.org/10.1016/j.spc.2020.12.031.

Un, C.A., Cuervo-Cazurra, A., Asakawa, K., 2010. R&D collaborations and product innovation. J. Prod. Innovat. Manag. 27 (5), 673–689. https://doi.org/10.1111/j.1540-5885.2010.00744.x.

Urban, F., 2015. Environmental innovation for sustainable development: the role of China. Sustain. Dev. (Bradf.) 23 (4), 203–205. https://doi.org/10.1002/sd.1587.

Van Eck, N.J., Waltman, L., 2014. Visualizing bibliometric networks. In: Measuring Scholarly Impact. Springer International Publishing, pp. 285–320. https://doi.org/10.1007/978-3-319-10377-8_13.

Wagner, M., Schaltegger, S., Hansen, E.G., Fichter, K., 2021. University-linked programmes for sustainable eSongntrepreneurship and regional development: how and with what impact? Small Bus. Econ. 56 (3), 1141–1158. https://doi.org/10.1007/s11187-019-00280-4.

Wang, W., Yu, B., Yan, X., Yao, X., Liu, Y., 2017. Estimation of innovation's green performance: a range-adjusted measure approach to assess the unified efficiency of China's manufacturing industry. J. Clean. Prod. 149, 919–924. https://doi.org/10.1016/j.jclepro.2017.02.174.

Waris, I., Barkat, W., Ahmed, A., Hameed, I., 2022. Fostering sustainable businesses: understanding sustainability-driven entrepreneurial intention among university students in Pakistan. Soc. Responsib. J. 18 (8), 1409–1426. https://doi.org/10.1108/SRJ-10-2020-0399.

Wee, H., 2022. How do green patents affect Follow-On green innovation? SSRN Electron. J. https://doi.org/10.2139/ssrn.4296541.

Xue, C., Wang, J., 2024. Proactive boundary-spanning search, organizational resilience, and radical green innovation. Bus. Strat. Environ. 33 (3), 1834–1852. https://doi.org/10.1002/bse.3576.

Yang, Y., 2024. Impact of institutional support and green knowledge transfer on university students' absorptive capacity and green entrepreneurial behavior: the moderating role of environmental responsibility. PLoS One 19 (5 May). https://doi.org/10.1371/journal.pone.0304070.

Yang, Z., Chen, H., Du, L., Lin, C., Lu, W., 2021. How does alliance-based government-university-industry foster cleantech innovation in a green innovation ecosystem? J. Clean. Prod. 283. https://doi.org/10.1016/j.jclepro.2020.124559.

Yi, G., 2021. From green entrepreneurial intentions to green entrepreneurial behaviors: the role of university entrepreneurial support and external institutional support. Int. Entrep. Manag. J. 17 (2), 963–979. https://doi.org/10.1007/s11365-020-00649-y.

Yi, H., Zhang, Q., 2022. Knowledge-sharing strategies of university-industry alliances promoting green technology innovation in ecosystems: based on the utility of multichannel funding. IEEE Access 10, 65728–65743. https://doi.org/10.1109/ACCESS.2022.3184422.

Yin, H., Zhang, J., Zhong, R., Ji, Q., 2023. Academic workstations and corporate green innovation. Int. Rev. Econ. Finance 83, 571–590. https://doi.org/10.1016/j.iref.2022.10.001.

Zampetakis, L.A., Manios, T., Moustakis, V., 2006. Greening the entrepreneurship syllabus: an exploratory approach. Environ. Eng. Manag. J. 5 (Issue 2). http://omicron.ch.tuiasi.ro/EEMJ/.

Zhang, F., Zhu, L., 2019. Enhancing corporate sustainable development: stakeholder pressures, organizational learning, and green innovation. Bus. Strat. Environ. 28 (6), 1012–1026. https://doi.org/10.1002/bse.2298.

Zhang, S., Xu, X., Wang, F., Zhang, J., 2022. Does cooperation stimulate firms' eco-innovation? firm-level evidence from China. Environ. Sci. Pollut. Control Ser. 29 (51), 78052–78068. https://doi.org/10.1007/s11356-022-21296-6.

Zhang, T., Haq, S. ul, Xu, X., Nadeem, M., 2024. Greening ambitions: exploring factors influencing university students' intentions for sustainable entrepreneurship. Int. Entrep. Manag. J. https://doi.org/10.1007/s11365-024-00991-5.

Zhou, X., Jia, M., Li, W., Zhao, X., Gatto, A., Ma, X., 2024. Higher education or scientific research: which one contributes more to China's green innovation? Soc. Econ. Plann. Sci. 94. https://doi.org/10.1016/j.seps.2024.101919.