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Sustainable Venture Readiness as a Graduation Stage Outcome of Sustainable Entrepreneurship Education Competence and Intention

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Abstract

Higher education institutions playing crucial role in training students for sustainable entrepreneurship, yet many studies treat entrepreneurial intention as the final educational outcome. This study examines how Sustainable Entrepreneurship Education shapes Sustainable Venture Readiness among Indian graduates through competence and intention. Drawing on Human Capital Theory, the sustainable entrepreneurship competence framework and the Theory of Planned Behavior, the study tests a competence-readiness model using data from 518 graduating students across twelve higher education institutions. Partial least squares structural equation modeling (PLS-SEM) was used to assess the measurement model, structural relationships, mediation predictive relevance and gender-based group differences. The findings show that Sustainable Entrepreneurship Education positively influences Sustainable Entrepreneurship Competence, which strengthens Sustainable Entrepreneurial Intention and Sustainable Venture Readiness. Sustainable Entrepreneurial Intention also contributes to Sustainable Venture Readiness and partially mediates the competence-readiness relationship. Complementary Necessary Condition Analysis shows that competence, education and intention have statistically significant and meaningful necessary-condition effects for achieving high Sustainable Venture Readiness, with competence showing the strongest effect. Gender-based multi-group analysis provides limited evidence that the intention-readiness relationship is stronger among female students, while competence-related group comparisons are interpreted cautiously because full measurement invariance was not established. The study contributes to Sustainable Development Goal 4 at the level of educational outcomes by shifting sustainable entrepreneurship education research from intention alone towards competence and readiness as measurable learning outcomes.

Introduction

Sustainable Entrepreneurship Education (SEE) is recognised as a distinct educational domain in which ecological and social challenges are treated as potential sources of entrepreneurial opportunity rather than merely as constraints on economic activity (Dean & McMullen, 2007; Shepherd & Patzelt, 2011; Cohen & Winn, 2007). Unlike conventional entrepreneurship education, SEE requires students to understand how economic, social and environmental value can be integrated within opportunity recognition and venture development (Schaltegger & Wagner, 2011; Terán-Yépez et al., 2020). Higher education institutions occupy a central position within this agenda: graduates are expected to recognise sustainability-linked opportunities, weigh social and ecological trade-offs, and translate course learning into early venture-development action (Biberhofer et al., 2019; Lans et al., 2014; Wiek et al., 2011).

Despite this ambition, a notable gap persists between sustainable entrepreneurship education outcomes and post-graduation readiness. Prior studies have provided valuable evidence on how Sustainable Entrepreneurship Education (SEE), sustainability-related competence and educational experiences shape students' Sustainable Entrepreneurial Intention (SEI) (Agu et al., 2021; Gamarra-Chávez et al., 2026; Hörisch et al., 2025; Joensuu-Salo et al., 2022). However, these studies do not position Sustainable Venture Readiness (SVR) as a distinct graduation-stage educational outcome within a SEE–Sustainable

Entrepreneurship Competence (SEC)–SEI pathway. This leaves a gap in understanding whether students who receive sustainable entrepreneurship education feel prepared for early sustainable venture-development action, beyond merely expressing intention. Research on entrepreneurial readiness has examined readiness within general entrepreneurship education, often through digital, financial or agility-related mechanisms rather than sustainability-specific venture preparedness (Hasan et al., 2024, 2025). Recent eco-preneurship education studies have examined sustainability and entrepreneurship competencies alongside eco-preneurial aspirations through experiential and interdisciplinary learning, yet they do not position SVR as a distinct graduation-stage outcome within a SEE–SEC–SEI model (Christou, Ioannou, et al., 2026; Christou, Yiatros, et al., 2026)

Intention and readiness are not equivalent constructs. Intention reflects a conscious plan, whereas readiness concerns whether students feel prepared to act. Treating intention as a terminal outcome is therefore limiting, since it does not indicate whether students possess the competence and preparedness required for early-stage sustainable venture development (Bae et al., 2014; Diepolder et al., 2021). This study examines four core constructs: SEE, SEC, SEI and SVR. Its contribution to the Sustainable Development Goal (SDG) 4 agenda lies in explaining how SEE supports competence formation, intention and perceived readiness for sustainable venture development. This contribution is framed deliberately as educational rather than outcome-based, since the empirical design measures perceived constructs among graduating students rather than actual venture creation or environmental impact.

The study examined the following research questions:

RQ1: How does SEE contribute to SEC among graduating students?

RQ2: How do SEC and SEI explain SVR?

RQ3: Does SEI mediate the SEC–SVR relationship?

RQ4: Which antecedent or condition shows stronger practical relevance for SVR under sufficiency and necessity logic?

RQ5: Do the structural relationships explaining SVR differ between male and female students?

These questions direct the study's focus towards how sustainability-oriented education develops competence, intention and readiness among graduating students in the Indian higher education context. Conceptually, the study positions SVR as a more action-proximal educational outcome than SEI. Theoretically, it integrates Human Capital Theory (HCT), the SEC framework and the Thoery of Planned Behaviour (TPB) to describe how SEE can develop competence, motivation and perceived venture readiness. Methodologically, it combines PLS-SEM with PLSpredict, MICOM/MGA and NCA to distinguish sufficient predictors from necessary bottleneck conditions. In doing so, the study offers an empirically grounded rationale for competence-centred and readiness-oriented curriculum design

aligned with the SDG 4 agenda, particularly skills for entrepreneurship and education for sustainable development.

Theoretical Background and Hypothesis Development

2.1 Sustainable Entrepreneurship as the Study Context

Sustainable entrepreneurship connects entrepreneurial action with sustainability-oriented value creation. Market imperfections, externalities and flawed pricing mechanisms generate opportunity spaces when entrepreneurial action reduces environmental or social inefficiencies (Dean & McMullen, 2007; Cohen & Winn, 2007; & Shepherd & Patzelt, 2011) link what is to be sustained, including nature, life-support systems and communities, with what is to be developed, including both economic and non-economic gains. Schaltegger & Wagner (2011) situate sustainable entrepreneurship in relation to sustainability innovation, embedding social and environmental goals within market-relevant activity. Given that sustainable entrepreneurship's conceptual boundaries remain fragmented across entrepreneurship, sustainability and management debates (Terán-Yépez et al., 2020), the present study treats it as the overarching context within which SEE, SEC, SEI and SVR are examined.

2.2 Sustainable Entrepreneurship Education as the Educational Input

SEE integrates entrepreneurship learning with sustainability-oriented knowledge, values, skills and action capabilities, requiring students to engage with responsible opportunity recognition, stakeholder collaboration, sustainable business modelling and creating a social or ecological value (Agu et al., 2021; Del Vecchio et al., 2021; Klapper & Fayolle, 2023; Rosário & Raimundo, 2024). Empirical evidence indicates that SEE operates through mechanism-based learning outcomes rather than as a direct pathway to venture creation: Agu et al. (2021) found that SEE influenced the antecedents of SEI without directly predicting SEI itself; Gamarra-Chávez et al. (2026) identified indirect effects operating through cognitive antecedents; and Hörisch et al. (2025) found that SEE interventions strengthened SEC, which in turn related positively to entrepreneurial intention. SEE is therefore positioned as an educational input that functions through competence and motivational mechanisms.

2.3 Sustainable Entrepreneurship Competence as Task-Specific Capability

SEC is operationally defined as students' perceived ability to identify sustainability-oriented entrepreneurial opportunities, balance economic, social and environmental considerations, evaluate future consequences, apply sustainability values and principles, collaborate with others and develop sustainable entrepreneurial solutions (Diepolder et al., 2021; Foucrier & Wiek, 2019; Wiek et al., 2011).

Sustainability competency includes interpersonal, normative, anticipatory, systems-thinking, and strategic components (Wiek et al., 2011). Lans et al., (2014) extend these to entrepreneurship through systems thinking, foresight, normative action, strategic management and self-efficacy. Foucrier & Wiek (2019) connect SEC to entrepreneurial stages from discovery through to start-up, whilst Joensuu-Salo et al. (2022) confirm that SEC significantly explains entrepreneurial intention in educational settings. In the present model, SEC is treated as the task-specific capability mechanism bridging SEE, SEI and SVR.

2.4 Sustainable Entrepreneurial Intention as the Motivational Mechanism

SEI is defined as students' conscious willingness or motivational orientation to pursue sustainable entrepreneurship or establish a sustainability-oriented venture. Entrepreneurial intention is a planned, goal-directed precursor to behaviour and should not be equated with actual action (Bae et al., 2014). Because sustainable entrepreneurship involves integrated economic, social and environmental value creation, intention models require sustainability-specific adaptation (Vuorio et al., 2018). Evidence indicates that sustainability-specific attitudes, perceived desirability, environmental and social and environmental values, and future implications on all shape SEI (Vuorio et al., 2018; Yasir et al., 2021; Lopes et al., 2023; Pascucci et al., 2022). Since intention alone does not reflect whether students feel equipped for early venture-development tasks, SEI serves here as a motivational mechanism whilst SVR provides the more action-proximal outcome.

2.5 Sustainable Venture Readiness as the Readiness Outcome

Sustainable venture readiness (SVR) refers to students' perceived preparedness at graduation to apply sustainable entrepreneurship learning to early venture-development activities. It is positioned as a readiness outcome rather than an intention outcome because intention reflects willingness to act, whereas readiness reflects whether students feel prepared to move towards action (Bae et al., 2014). Prior entrepreneurship education studies have examined entrepreneurial readiness mainly in general entrepreneurial contexts, including digital business literacy, financial literacy and agility-related readiness mechanisms (Hasan et al., 2024, 2025). However, these models do not fully capture sustainability-specific preparedness for developing ventures that address social, environmental and economic concerns.

In this study, SVR is adapted from the Work Readiness Scale of Caballero et al. (2011), which provides a foundation for measuring perceived preparedness for work-related performance. The construct is contextualised for sustainable entrepreneurship by drawing on competence and venture-process literature. Lans et al. (2014) support the relevance of opportunity recognition, stakeholder interaction and sustainability-oriented competence in higher education, while Foucrier & Wiek (2019) link sustainability

entrepreneurship competence to entrepreneurial process stages such as discovery, planning, start-up and consolidation. Accordingly, SVR is measured through students' perceived preparedness to apply sustainability learning, prepare a sustainable venture plan, understand implementation steps, seek guidance from mentors or support organisations, build stakeholder relationships and convert sustainability problems into viable venture opportunities.

SVR is therefore treated as perceived readiness for early sustainable venture development, not as actual venture creation, business performance or verified sustainability impact. This distinction allows the study to use SVR as a cautious educational outcome that is closer to action than sustainable entrepreneurial intention, while avoiding overclaims about actual entrepreneurial behaviour or environmental and social outcomes.

2.6 Theoretical Foundation of the Proposed Model

HCT provides the primary theoretical foundation because SEE is treated as an educational investment in task-relevant knowledge and skills. Task-specific human capital relates more strongly to entrepreneurial outcomes than general human capital (Unger et al., 2011), and entrepreneurship education is associated with knowledge, skills and positive entrepreneurship-related perceptions (Martin et al., 2013). The SEC framework specifies the sustainability-oriented form of task-specific human capital pertinent to this study (Lans et al., 2014; Wiek et al., 2011). TPB provides the supporting motivational lens, with SEI representing the bridge between competence and readiness: social norms, sustainability-specific attitudes, and perceived behavioral control all contribute to SEI (Lopes et al., 2023; Vuorio et al., 2018; Yasir et al., 2021). Together, HCT, the SEC framework and TPB support a mechanism-based model in which SEE develops SEC, SEC strengthens both SEI and SVR, and SEI carries part of the competence-to-readiness pathway.

2.7 Hypotheses Development

2.7.1 Sustainable Entrepreneurship Education and Sustainable Entrepreneurship Competence

SEE equips students with abilities and mindset necessary to evaluate possibilities in relation to environmental and societal needs (Diepolder et al., 2021). From an HCT perspective, education and training develop task-relevant knowledge that enhances entrepreneurial capability (Martin et al., 2013; Unger et al., 2011), and recent evidence supports the view that SEE interventions can strengthen SEC and its antecedents (Gamarra-Chávez et al., 2026; Hörisch et al., 2025).

h2. SEE positively influences SEC among graduating students.

2.7.2 Sustainable Entrepreneurship competence and Sustainable Entrepreneurial Intention

Students who perceive themselves as competent in sustainability-oriented opportunity recognition and stakeholder engagement are more inclined to develop entrepreneurial motivation. SEC encompasses systems thinking, foresight, normative, action and interpersonal competencies (Lans et al.,2014; Ploum et al., 2018), and both Joensuu-Salo et al., (2022) and Hörisch et al., (2025) report a strong positive correlation between SEC and entrepreneurial intention.

H2. SEC positively influences SEI among graduating students.

2.7.3 Sustainable Entrepreneurship Competence and Sustainable Venture Readiness

Readiness for sustainable venture development requires capability in identifying sustainability-oriented opportunities, evaluating social and environmental trade-offs and preparing early venture-development steps. Competence frameworks emphasise systems thinking, anticipatory, normative, strategic and interpersonal competencies for addressing complex sustainability challenges (Lans et al., 2014; Ploum et al., 2018; Wiek et al.,2011), and Foucrier & Wiek (2019) explicitly link SEC to entrepreneurial stages including discovery and start-up.

H3. SEC positively influences SVR among graduating students.

2.7.4 Sustainable Entrepreneurial Intention and Sustainable Venture Readiness

Entrepreneurial intention is a goal-directed precursor to behaviour (Bae et al., 2014), and students with stronger SEI are expected to be more cognitively prepared for initial sustainable venture-development steps. SEI is shaped by sustainability-specific attitudes, perceived feasibility, social norms, environmental values and considering future potential outcomes (Pascucci et al.,2022; Vuorio et al., 2018; & Yasir et al., 2021).

H4. SEI positively influences SVR among graduating students.

2.7.5 Mediating Role of Sustainable Entrepreneurial Intention

SEC may strengthen readiness partly by increasing students' motivation to pursue sustainable entrepreneurship. Joensuu-Salo et al. (2022) confirm a significant SEC-intention relationship, and intention represents the motivational state that precedes planned entrepreneurial behaviour (Bae et al.,

2014; Vuorio et al., 2018) Given that SEC also directly supports readiness through task-specific capability, the mediation is expected to be partial rather than full.

H5. SEI mediates the relationship between SEC and SVR.

2.7.6 Moderating role of Gender

Gender is examined as a grouping variable to test whether structural relationships operate equivalently for male and female students. Before interpreting group differences, measurement invariance must be established through the Measurement Invariance of Composite Models (MICOM) procedure, since path comparisons may be deceptive when constructs are not measured equally across groups (Henseler et al., 2016; Sarstedt et al., 2011).

H6. Gender-based differences exist in one or more structural relationships in the model.

Methodology

3.1 Research Design

The study philosophy was based on positivism, the approach was deductive and a quantitative cross-sectional survey was employed, In order to investigate the theory-derived link between the latent constructs. Partial least squares structural equation modeling, or PLS-SEM, was employed because the proposed model incorporates many endogenous determinants, direct effect, mediation, predictive evaluation, and gender-based group comparison. (Hair et al., 2022). For reflective measurement model assessment, structural model testing, bootstrapping, PLSpredict, Necessary Condition Analysis (NCA) and Multi-Group Analysis (MGA) were performed by using SmartPLS. The design was a multi-institutional cross-sectional survey and data were collected cross-sectionally from graduating students in various higher education institutions in India. Respondents were students who had taken a formal course or some structured learning exposure on sustainable entrepreneurship. The choice of this design was suitable for the study focused on students' perceptions of their current concerns of sustainable entrepreneurship exposure, competence, intention and venture readiness at the graduation stage. Multiple institutional settings enabled for a wider representation of various educational environments. The unit of analysis was the graduating student.

3.2 Sampling and date collection

The target demographic consisted of undergraduate and postgraduate graduating students who had completed a regular sustainable entrepreneurship course, thereby ensuring adequate exposure to meaningfully assess all four constructs. Students who had attended only workshops, seminars or general entrepreneurship training were excluded. Criterion-based purposive sampling was applied across twelve higher education institutions in India. Of 700 distributed questionnaires, 518 valid responses were

retained following screening and data cleaning, representing a response rate of 74.0%. Sample-size adequacy was assessed using the inverse square root method of Kock & Hadaya (2018), which recommends a conservative minimum of 160 responses when the minimum expected path coefficient is unknown in advance. The final sample of 518 exceeded this requirement, providing a stronger basis for estimating direct effects, the indirect effect and effect sizes within the PLS-SEM model.

3.3 Measures

Each construct was measured on a five-point Likert scale, where 1 represents strongly disagree and 5 represents strongly agree. SEE was measured with five items capturing students' perceived course exposure to sustainable entrepreneurship knowledge, creativity, venture-related skills, sustainable business idea planning and the connection between entrepreneurship, sustainability, social value and environmental responsibility. The items were adapted and contextualised from sustainable entrepreneurship education literature (Agu et al., 2021; Gamarra-Chávez et al., 2026). SEC was measured with six items capturing students' perceived ability to identify sustainable entrepreneurial opportunities, balance economic, social and environmental considerations, reduce negative social or environmental effects, consider future consequences, apply sustainability principles and collaborate for sustainable solutions. The items were adapted and contextualised from sustainable entrepreneurship competence literature (Hörisch et al., 2025; Lans et al., 2014). SEI was measured with four items capturing students' goal, intention and willingness to pursue sustainable entrepreneurship, including a commitment to social and environmental value alongside profit. The items were adapted and contextualised from Yasir et al. (2021). SVR was measured with six items capturing students' perceived preparedness to apply SEE learning, prepare a sustainable venture plan, understand implementation steps, learn from mentors or support organisations, build stakeholder relationships and convert sustainability problems into venture opportunities. The items were adapted from work readiness literature and contextualised through sustainable entrepreneurship competence and venture-process literature (Caballero et al., 2011; Foucrier & Wiek, 2019; Lans et al., 2014).

3.4 Common Method Bias

Procedural and statistical remedies were used to reduce common method bias. Participation was voluntary and anonymous, and respondents were informed that there were no right or wrong answers. Statistically, common method bias was assessed using the full collinearity variance inflation factor (VIF) approach with a threshold of 3.3 (Kock, 2015). VIF values were SEC = 2.611, SEE = 1.699, SEI = 2.200 and SVR = 2.776, ranging from 1.699 to 2.776. All values fell below 3.3, indicating that common method bias was not a serious concern.

3.5 Data Analysis

A sequential PLS-SEM procedure was followed. First, the reflective measurement model was assessed using outer loadings, Cronbach's alpha, Dijkstra-Henseler's rho_A, composite reliability (CR) and average variance extracted (AVE), following established PLS-SEM assessment guidelines (Hair et al., 2022). Discriminant validity was assessed using the heterotrait-monotrait ratio (HTMT), which is more sensitive than the Fornell-Larcker criterion (Henseler et al., 2015). Second, the structural model was assessed using standardised path coefficients, bootstrapped t-values, p-values, 95% confidence intervals, R^2, adjusted R^2 and f^2 effect sizes. Third, out-of-sample predictive relevance was evaluated via PLSpredict, reporting Q^2predict, root mean square error (RMSE) and mean absolute error (MAE) (Shmueli et al., 2016, 2019). Fourth, mediation was tested using bootstrapping of indirect effects (Nitzl et al., 2016; Zhao et al., 2010). Fifth, NCA was used to complement PLS-SEM by identifying whether the antecedents of SVR represent must-have bottleneck conditions rather than only should-have sufficient predictors (Dul, 2016; Richter et al., 2020). The NCA was interpreted using ceiling envelopment-free disposal hull (CE-FDH) and ceiling regression-free disposal hull (CR-FDH) effect sizes, with d >= .10 indicating a meaningful necessary condition (Dul, 2016; Richter et al., 2020). Approximate permutation testing at a 5% significance level was performed using 5,000 permutations to test the statistical significance of the NCA effect sizes. CE-FDH and CR-FDH effect sizes, permutation p values and bottleneck values were used to interpret NCA findings. Finally, MGA for gender was performed after the MICOM measurement invariance assessment (Henseler et al., 2016; Sarstedt et al., 2011).

3.6 Ethical Considerations

The study involved an anonymous and voluntary survey of graduating students. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. Participants were informed about the purpose of the study and their right to withdraw from participation. No personally identifiable or sensitive information was collected, and confidentiality and anonymity were maintained throughout the research process. In accordance with the institutional exemption guidelines issued by the Kasturba Medical College and Kasturba Hospital Institutional Ethics Committee, Manipal, India, the study was exempt from submission for formal Institutional Ethics Committee review. Further details are provided in the Ethical Approval and accordance statement.

Results

4.1 Demographic Profile

The sample's demographics are displayed in Table 1. The sample was balanced by gender, with 51.0% female and 49.0% male respondents. The majority of respondents fell within the 20-25 age bracket, consistent with the graduating-student context. Undergraduate students comprised 62.9% of the sample, and 68.7% reported no family business background, suggesting that responses primarily reflect formal course exposure rather than prior entrepreneurial socialisation.

Table 1. Demographic Profile of Respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	254	49.0
	Female	264	51.0
Age	Below 20	74	14.3
	20-25	392	75.7
	25 and above	52	10.0
Level of study	Undergraduate	326	62.9
	Postgraduate	192	37.1
Type of institution	Affiliated college	226	43.6
	Autonomous college	184	35.5
	Deemed university	108	20.9
Family business background	Yes	162	31.3
	No	356	68.7

Note. N = 518. Source. Author's survey data.

4.2 Measurement Model Assessment

The measurement model was assessed prior to structural model testing. As illustrated in Fig. 2 and reported in Table 2, all outer loadings ranged from .796 to .878, exceeding the recommended minimum loading threshold of .708 for indicator reliability (Hair et al., 2022). Cronbach's alpha values ranged from .879 to .910, Dijkstra-Henseler's rho_A values ranged from .880 to .911 and composite reliability values ranged from .917 to .93. These values exceeded the recommended .70 threshold and remained below .95, confirming internal consistency reliability without indicating serious item redundancy (Hair et al., 2022). Average variance extracted values ranged from .688 to .734, above the specified .50 threshold and demonstrating convergent validity (Hair et al., 2022). Overall, the reflective measurement model met the recommended reliability and convergent validity criteria.

Table 2. Construct Reliability, Validity and Outer Loadings

Construct	Item	Item Statement	OL	α	ρA	CR	AVE
Sustainable Entrepreneurship Education	SEE1	The full-time sustainable entrepreneurship course encouraged me to develop creative ideas for sustainability-oriented ventures.	.867	.899	.900	.925	.712
	SEE2	The course provided me with the necessary knowledge about sustainable entrepreneurship.	.850				
	SEE3	The course developed my skills and abilities for creating sustainability-oriented ventures.	.828				
	SEE4	The course helped me understand how sustainable business ideas can be identified, planned and implemented.	.841				
	SEE5	The course helped me connect entrepreneurship with sustainability, social value and environmental responsibility.	.833				
Sustainable Entrepreneurship Competence	SEC1	I am able to identify entrepreneurial opportunities that contribute to sustainable development.	.841	.910	.910	.930	.689
	SEC2	I am able to balance economic, social and environmental considerations when developing a venture idea.	.830				
	SEC3	I am able to analyse a business idea and suggest improvements that reduce negative social or environmental effects.	.824				
	SEC4	I am able to consider the future social and environmental consequences of a sustainable venture idea.	.825				
	SEC5	I am able to apply sustainability values and principles when judging a business opportunity.	.827				

	SEC6	I am able to collaborate with others to develop sustainable entrepreneurial solutions.	.831				
Sustainable Entrepreneurial Intention	SEI1	My goal is to become a sustainable entrepreneur after graduation.	.878	.879	.880	.917	.734
	SEI2	I intend to start a sustainable enterprise that addresses a social or environmental problem in the future.	.849				
	SEI3	If I start my own venture, I would give importance to social and environmental value along with profit.	.855				
	SEI4	I am willing to make serious effort to become a sustainable entrepreneur.	.845				
Sustainable Venture Readiness	SVR1	I feel prepared to apply my sustainable entrepreneurship learning to develop a venture idea.	.834	.909	.911	.930	.688
	SVR2	I feel prepared to apply my sustainability-related knowledge in preparing a sustainable venture plan.	.845				
	SVR3	I understand the main steps required to move a sustainable business idea towards implementation.	.806				
	SVR4	I feel prepared to learn from mentors, teachers or support organisations to develop a sustainable venture.	.842				
	SVR5	I feel prepared to build relationships with stakeholders who can support sustainable venture development.	.796				
	SVR6	I feel prepared to analyse sustainability problems and convert them into viable venture opportunities.	.852				

Note. OL = outer loading; α = Cronbach's alpha; ρA = Dijkstra-Henseler's rho_A; CR = composite reliability; AVE = average variance extracted. Source. Author's survey data and SmartPLS output.

4.3 Discriminant Validity

discriminant validity was evaluated using HTMT prior to interpreting the structural paths. According to Henseler et al. (2015), all HTMT values were below than the.85 cutoff point needed to prove discriminant validity. The greatest value between SEC and SVR (.834), which remained within the threshold despite the conceptual proximity between competence and readiness. In Table 3, the results are presented.

Table 3. HTMT Results

Construct	SEC	SEE	SEI	SVR
SEC	–			
SEE	.697	–		
SEI	.741	.536	–	
SVR	.834	.633	.808	–

Note. HTMT = heterotrait-monotrait ratio. Values below .85 indicate acceptable discriminant validity. Source. Author's survey data and SmartPLS output.

4.4 Structural Model

The structural model was assessed upon confirmation of the measurement model adequacy. Table 4 demonstrates that every direct link was positive and statistically significant at p <.001. The 95% percentile bootstrap confidence intervals did not include zero, further supporting the hypothesised relationships. The results support the proposed SEE-SEC-SEI-SVR pathway, with SEC emerging as the central construct by significantly explaining both SEI and SVR. The significant indirect effect of SEC on SVR through SEI indicates partial mediation, as the direct SEC -> SVR path remained significant after SEI was included. Model-fit and collinearity diagnostics were also examined. Hair et al. (2022) report that the standardized root mean square residual (SRMR) value was.046, below the recommended threshold for a good model fit All of the inner VIF values, which ranged from 1.000 to 1.788, were below the structural collinearity criterion (Hair et al., 2022).

Table 4. Path Analysis with Mediation and 95% Confidence Intervals

Relationship	β	Mean	STDEV	t-value	p-value	95% CI [2.5%, 97.5%]
SEE -> SEC	.632	.633	.027	23.475	<.001	[.579, .683]
SEC -> SEI	.664	.665	.024	27.313	<.001	[.615, .711]
SEC -> SVR	.499	.498	.034	14.591	<.001	[.429, .565]
SEI -> SVR	.393	.393	.035	11.135	<.001	[.323, .463]
SEC -> SEI -> SVR (indirect)	.261	.262	.025	10.294	<.001	[.213, .313]

Note. β = standardised path coefficient; STDEV = standard deviation; CI = confidence interval. Confidence intervals are based on 2.5% and 97.5% percentile bootstrap limits. Source. Author's survey data and SmartPLS output.

4.5 Effect size, Explanatory Power and Predictive Relevance

Effect size, explanatory power and predictive assessment results are presented in Table 5. SEC demonstrated the strongest practical role in the model, particularly in explaining SEI and SVR. With respect to SVR, SEC showed a stronger practical contribution than SEI, as indicated by its larger f^2 effect size. This reinforces competence as the more relevant antecedent of readiness under sufficiency logic. The R^2 value for SVR indicates substantial explanatory power, while the R^2 values for SEC and SEI indicate moderate explanatory power (Hair et al., 2022). All endogenous constructs show positive Q^2predict values (Hair et al., 2022; Shmueli et al., 2016, 2019), suggesting that the model has predictive relevance beyond the most naïve benchmark. Prediction errors were measured using root mean square error (RMSE) and mean absolute error (MAE), with corresponding values of .780 and .629 for SEC, .885 and .727 for SEI, and .829 and .686 for SVR, respectively. The PLS predict results are interpreted cautiously as evidence of positive predictive relevance rather than strong out-of-sample predictive power because the available output reports prediction errors but not the linear model benchmark comparison. Effect sizes and explanatory power were interpreted in accordance with PLS-SEM reporting guidelines (Hair et al., 2022).

Table 5. Effect Size, Explanatory Power and Predictive Relevance

Construct / Relationship	f^2	R^2	Adjusted R^2	Q^2predict	Interpretation
SEE -> SEC	.663	—	—	—	Large effect
SEC	—	.399	.398	.396	Moderate explanatory power; positive predictive relevance
SEC -> SEI	.788	—	—	—	Large effect
SEI	—	.441	.440	.223	Moderate explanatory power; positive predictive relevance
SEC -> SVR	.413	—	—	—	Large effect
SEI -> SVR	.256	—	—	—	Medium effect
SVR	—	.663	.662	.318	Substantial explanatory power; positive predictive relevance

Note. f^2 = effect size; R^2 = coefficient of determination; Q^2predict = predictive relevance indicator. Source. Author's survey data and SmartPLS output.

4.6 Necessary condition Analysis (NCA)

NCA was conducted to complement the PLS-SEM results by examining whether SEE, SEC and SEI represent necessary conditions for achieving higher levels of SVR. This additional analysis follows a necessity logic: whilst PLS-SEM estimates whether higher levels of a predictor are associated with higher levels of an outcome, NCA assesses whether a minimum level of a condition is required before a desired level of the outcome can be reached (Dul, 2016; Richter et al., 2020). The NCA ceiling line plots are presented in Fig. 4, and the effect size results are summarised in Table 6.

Table 6. Necessary Condition Analysis Effect Size and Permutation Results for Sustainable Venture Readiness

Condition	Outcome	CE-FDH d	CE-FDH permutation p value	CR-FDH d	CR-FDH permutation p value	CR-FDH accuracy (%)	Necessity relevance
SEC	SVR	.201	< .001	.206	< .001	98.263	Significant necessity effect; strongest bottleneck
SEE	SVR	.107	< .001	.123	< .001	98.649	Significant necessity effect; weakest bottleneck
SEI	SVR	.185	< .001	.185	< .001	98.456	Significant necessity effect

Note. CE-FDH = ceiling envelopment-free disposal hull; CR-FDH = ceiling regression-free disposal hull; d = necessity effect size; SEC = Sustainable Entrepreneurship Competence; SEE = Sustainable Entrepreneurship Education; SEI = Sustainable Entrepreneurial Intention; SVR = Sustainable Venture Readiness. Permutation p values are reported as $p < .001$ instead of .000.

Source. Author's survey data and SmartPLS/NCA permutation output.

Necessary-condition effects of SEC, SEE and SEI for SVR were found meaningful in NCA results. As indicated in Table 6, the CE-FDH effect sizes for SEC, SEE and SEI were .201, .107 and .185 respectively, which all met the criterion (d ≥ .10) for a meaningful necessity effect as recommended by Dul (2016). The CR-FDH results were consistent with this trend showing effect sizes of .206, .123, and .185, respectively, and accuracy rates of > 98% for all three ceiling lines. All necessary-condition effects were statistically significant for both the CE-FDH and CR-FDH ceiling lines (p < .001) as per the NCA approximate permutation test logic (Dul et al., 2020). SEC had the most significant necessity effect of the three antecedents, followed by SEI and SEE. These findings suggest that there are minimum threshold levels of competence, intention and educational exposure that are required to achieve high SVR.

Table 7. Bottleneck Table for Sustainable Venture Readiness using CE-FDH Percentiles

Desired SVR level	Required SEC percentile	Required SEE percentile	Required SEI percentile
0%	NN	NN	NN
10%	NN	NN	NN
20%	1.158	.386	NN
30%	1.158	.386	NN
40%	1.158	.386	1.737
50%	3.089	.579	4.633
60%	3.089	3.475	8.880
70%	3.089	3.475	8.880
80%	25.676	3.475	11.004
90%	37.645	3.475	36.100
100%	49.035	34.170	55.212
Note. NN = not necessary. Values indicate the minimum percentile level of each condition required to achieve the corresponding level of SVR.			

Source. Author's survey data and SmartPLS/NCA output.

The bottleneck table provides a practical interpretation of the ceiling-line results. NCA identifies the minimum level of a condition required to reach a specific level of the outcome, and the bottleneck table presents these requirements in tabular form (Dul, 2016; Richter et al., 2020). At lower levels of SVR, the required levels of SEE, SEC and SEI are minimal or not necessary. However, at higher readiness levels, the bottleneck requirements increase, especially for SEC and SEI. For example, achieving 90% of SVR requires SEC at the 37.645 percentile and SEI at the 36.100 percentile, whereas SEE is required only at the 3.475 percentile. At the maximum level of SVR, the required levels increase to 49.035 for SEC, 34.170 for SEE and 55.212 for SEI. These findings suggest that SEE provides an educational foundation, but higher levels of readiness depend more strongly on whether students develop adequate competence and intention.

4.7 Gender-Based Multi-Group Analysis

Gender-based multi-group analysis (MGA) was conducted to address RQ5. Measurement invariance was first assessed using the measurement invariance of composites (MICOM) procedure, as invariance assessment is required before making meaningful group comparisons in PLS-SEM (Hair et al., 2022; Henseler et al., 2016). MICOM established compositional invariance for SEE, SEI and SVR, but not for SEC ($p = .029$). Equality of variances was also not supported for SEC ($p = .042$). Therefore, path

comparisons involving SEC were treated as non-conclusive. PLS-MGA showed a significant gender difference only for the SEI → SVR path, with a male-female difference of -.280 (two-tailed $p < .001$). As this difference was calculated as male minus female, the SEI → SVR relationship was stronger among female students. Accordingly, H6 received limited partial support and is interpreted cautiously rather than as full model-level gender moderation (Hair et al., 2022; Sarstedt et al., 2011)).

4.8 Hypotheses Summary

Table 8 consolidates the statistical decisions for all hypotheses, linking empirical results to the proposed conceptual model.

Table 8. Hypotheses Summary

H	Relationship	Result	Decision
H1	SEE -> SEC	β = .632, t = 23.475, p < .001, 95% CI [.579, .683]	Supported
H2	SEC -> SEI	β = .664, t = 27.313, p < .001, 95% CI [.615, .711]	Supported
H3	SEC -> SVR	β = .499, t = 14.591, p < .001, 95% CI [.429, .565]	Supported
H4	SEI -> SVR	β = .393, t = 11.135, p < .001, 95% CI [.323, .463]	Supported
H5	SEC -> SEI -> SVR (mediation)	β = .261, t = 10.294, p < .001, 95% CI [.213, .313]	Supported
H6	Gender moderates structural relationships in the SEE-SEC-SEI-SVR model	MICOM incomplete for SEC; SEI -> SVR showed significant gender difference (male-female = -.280, two-tailed p < .001)	Limited partial support

Note. CI = confidence interval.

Source. Author's work based on SmartPLS output.

Discussion

The results support the mechanism-based argument that SEE contributes to SVR through competence and motivational pathways. Addressing RQ1, SEE strengthens students' perceived sustainability-oriented entrepreneurial competence, as evidenced by the significant SEE → SEC path confirming H1. Full-time course exposure is associated with students' ability to recognise sustainability-linked opportunities, balance economic, social and environmental considerations and collaborate for sustainability-oriented solutions. This aligns with prior evidence that SEE strengthens competence-related and cognitive antecedents rather than directly demonstrating venture-creation outcomes (Agu et al., 2021; Gamarra-

Chávez et al., 2026; Hörisch et al., 2025) and supports the HCT argument that education develops task-specific human capital (Martin et al., 2013; Unger et al., 2011). In relation to SDG 4, this suggests an educational-outcome contribution, particularly to Target 4.4 on entrepreneurship-relevant skills and Target 4.7 on knowledge and skills for sustainable development. Addressing RQ2, both SEC and SEI significantly explain SVR, with SEC emerging as the stronger direct predictor. This supports H3 and H4 and suggests that readiness for sustainable venture development depends not only on motivation but also on task-specific competence. The result is consistent with competence-framework literature, which holds that sustainability-oriented entrepreneurship requires systems thinking, strategic action, normative judgement, collaboration and opportunity-related capability (Foucrier & Wiek, 2019; Lans et al., 2014; Wiek et al., 2011). SEI also contributes to SVR, consistent with intention literature treating entrepreneurial intention as a planned motivational precursor to action (Bae et al., 2014; Vuorio et al., 2018). However, the stronger effect of SEC indicates that intention alone does not explain readiness as strongly as competence. This strengthens the study's SDG 4 contribution by suggesting that higher education should prioritise competence-building as a practical learning outcome rather than relying solely on intention-building.

Addressing RQ3, SEI partially mediates the SEC–SVR relationship, with the significant indirect effect supporting H5. SEC explains SVR both directly through capability and indirectly through motivation. This is consistent with evidence that SEC explains entrepreneurial intention (Hörisch et al., 2025; Joensuu-Salo et al., 2022) and with mediation logic that direct and indirect effects should be interpreted jointly (Zhao et al., 2010). For SDG 4, this implies that sustainable entrepreneurship courses should develop both capability and motivation, whilst recognising that competence remains the foundation of readiness.

The NCA results provide support for the PLS-SEM results and demonstrate that SEE, SEC and SEI have statistically significant and meaningful necessity effects for attaining high SVR. The need was greatest for SEC, then SEI, and then SEE. This pattern contributes to the core statement of the study: while sustainable entrepreneurship courses may give students the necessary educational grounding, students need to reach minimum competence and intention thresholds to be more ready. The bottleneck table also reveals that the demands increase as the level of SVR increases, particularly in the case of SEC and SEI. Therefore, competence and intention should not only be considered as variables that increase the readiness in the mean, but also as practical readiness thresholds. This finding introduces a new need perspective to the PLS-SEM sufficiency logic and suggests that above and below threshold values of competence, intention and educational exposure are necessary to achieve a high SVR. (Dul, 2016; Richter et al., 2020).

Addressing RQ5, gender-based MGA provided limited partial evidence of group difference. The SEI → SVR relationship was stronger among female students, suggesting that intention may translate into readiness more strongly for women in the present sample. However, because SEC did not establish compositional invariance, group comparisons involving SEC cannot be interpreted as conclusive. The study therefore avoids broad claims about gender moderation across the full model.

Taken together, the results contribute to sustainability-oriented higher education by suggesting that SEE is most valuable when it develops competence, intention and perceived readiness for sustainable venture development. No claims are made regarding actual start-up creation, employment generation or environmental impact. Rather, the contribution to SDG 4 lies in identifying measurable educational outcomes: competence formation, motivational development and readiness for early venture-development action. These outcomes can be reinforced through curriculum design, mentoring, stakeholder engagement and readiness-based assessment.

Implications

6.1 Theoretical implications

This study contributes to sustainable entrepreneurship education literature by extending the way educational outcomes are understood and assessed. First, it moves beyond the intention-dominant approach by positioning Sustainable Venture Readiness as a more action-proximal outcome. This distinction is important because students may express a willingness to pursue sustainable entrepreneurship without feeling prepared to identify sustainability problems, evaluate social and environmental trade-offs, prepare venture plans or engage stakeholders. Second, the study positions Sustainable Entrepreneurship Competence as the central capability mechanism linking Sustainable Entrepreneurship Education with both intention and readiness. This supports the view that sustainable entrepreneurship education should be understood as a task-specific human capital development process, not merely as awareness creation or intention formation.

The study also contributes by integrating Human Capital Theory, the sustainable entrepreneurship competence framework and the Theory of Planned Behaviour into a single competence-readiness explanation. Human Capital Theory explains how education develops task-relevant knowledge and skills, the competence framework specifies the sustainability-oriented capability needed for opportunity recognition and venture preparation, and the Theory of Planned Behaviour explains how intention carries part of the motivational pathway towards readiness. Finally, the use of necessary condition analysis extends the interpretation from sufficiency logic to necessity logic. While PLS-SEM shows that competence and intention positively explain readiness, NCA indicates that competence, intention and educational exposure also act as meaningful bottleneck conditions for achieving high Sustainable Venture Readiness in the observed data. In this way, the study contributes to Sustainable Development Goal 4 by identifying competence, intention and readiness as measurable education-based outcomes that support preparedness for sustainability-oriented entrepreneurial action, without claiming actual venture creation or direct environmental impact.

6.2 Practical implications

The findings suggest that higher education institutions should assess sustainable entrepreneurship education through readiness-based learning outcomes rather than intention alone. In sustainability-oriented entrepreneurship, students need more than interest or willingness. They should be able to recognise sustainability problems, evaluate social and environmental consequences, develop sustainable business model ideas, seek guidance and work with stakeholders. Sustainable Venture Readiness can therefore be used as a programme-level outcome to assess whether students are prepared to apply sustainability learning beyond the classroom.

Curriculum designers should translate this readiness focus into competence-centred teaching. Courses can include local sustainability problem identification, stakeholder mapping, trade-off analysis, sustainable business model development, early venture planning, field-based assignments and community-linked sustainability challenges. Since Sustainable Entrepreneurship Competence showed the strongest direct and necessity role, institutions should give priority to project-based learning, mentoring, incubation exposure and interdisciplinary collaboration. These activities can help students move from general sustainability awareness to practical preparation for sustainability-oriented venture development.

The NCA findings add a bottleneck perspective for educators and entrepreneurship cells. High Sustainable Venture Readiness requires minimum levels of competence, intention and educational exposure in the observed data. Therefore, institutions should not evaluate sustainable entrepreneurship courses only by whether students report stronger entrepreneurial intention. They should also identify students with weak competence or low intention and provide targeted support through guided venture planning, peer learning, mentoring, incubation orientation and stakeholder engagement. For policymakers and higher education regulators, the findings support Sustainable Development Goal 4-aligned entrepreneurship curricula that assess what students are prepared to do for sustainability-oriented venture development, not only what they intend to do.

Limitations and Future Research

The study has presented some important evidence of the role sustainable entrepreneurship education plays in allowing for competence, intention and venture readiness; however, it needs to be considered in the framework of some limitations. Because the data is a cross-section and self-reported, it does not allow for conclusions regarding actual venture behaviour. Longitudinal or intervention designs could be used in future research to assess if mentoring, exposure to incubation, venture labs and sustainability business model workshops result in tangible activity (e.g. prototype development, funding efforts, team formation, or venture creation). The study focused only on the graduating students from the selected higher educational institutions of India; so future study could be carried out on the model in various regions, disciplines, types of institutions and countries. Additional research may also consider whether or not the NCA bottlenecks that emerged from this study are consistent across student cohorts and educational contexts.

Conclusion

This study concludes that sustainable entrepreneurship education gains stronger meaning when it is examined through competence and readiness, rather than through entrepreneurial intention alone. The findings show that education contributes to students' preparedness for sustainability-oriented venture development by strengthening their perceived competence and motivation. However, competence emerged as the most important pathway, suggesting that students become more ready for sustainable venture development when they feel capable of identifying sustainability problems, evaluating social and environmental trade-offs, developing venture ideas and engaging relevant stakeholders. The study also adds a necessity perspective by showing that high sustainable venture readiness depends on minimum levels of education, competence and intention, with competence forming the strongest bottleneck condition. This strengthens the central argument that sustainable entrepreneurship education should be assessed not only by whether students intend to start sustainable ventures, but also by whether they develop the capability and readiness needed for early venture-development action. The gender-based analysis offered a cautious additional insight, as the link between sustainable entrepreneurial intention and sustainable venture readiness was stronger among female students, while competence-related gender comparisons require careful interpretation. Overall, the study advances a competence-readiness perspective in sustainable entrepreneurship education and connects with Sustainable Development Goal 4 by focusing on education, skills, competence formation and readiness for sustainability-oriented entrepreneurial action, without claiming actual venture creation or direct environmental impact.

Declarations

Ethics approval and consent to participate

This study involved an anonymous, voluntary, non-invasive educational survey of graduating students. In accordance with the institutional guidelines *"Projects Exempt from Submission to IEC"* issued by the Kasturba Medical College and Kasturba Hospital Institutional Ethics Committee, Manipal, India (Registration No. ECR/146/Inst/KA/2013/RR-19; DHR Registration No. EC/NEW/INST/2022/KA/0042), the study fell within the category of research exempt from submission for formal Institutional Ethics Committee review. Accordingly, separate IEC approval was not required. The research was conducted in accordance with the applicable institutional ethical guidelines and the principles of the Declaration of Helsinki. Participation was voluntary, and informed consent was obtained from all participants prior to participation. Respondents were informed of the purpose of the study and their right to withdraw. No personally identifiable or sensitive information was collected, and confidentiality and anonymity were maintained throughout the study.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

M. Sandhya identified the research problem, developed the research questions, planned and guided the study, contributed to the review of literature, supervised the data collection, and reviewed the data analysis, interpretation of results, discussion, and overall manuscript. Raghavendra contributed to the review of literature, development of the conceptual framework, data collection, data analysis, interpretation of results, and writing and improving the discussion. Deekshitha contributed to the development of the conceptual framework, reviewed the complete manuscript, and contributed to writing, reviewing, and improving the discussion and implications. Ashwini Crasta contributed to the review of literature, data collection, and writing and improving the discussion and implications. Sonika and Soumyashree Ramdas Bangera contributed to the review of literature, and data collection. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for the accuracy and integrity of the work.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

1. Agu AG, Kalu OO, Esi-Ubani CO, Agu PC. Drivers of sustainable entrepreneurial intentions among university students: an integrated model from a developing world context. Int J Sustain High Educ. 2021;22(3):659–80. https://doi.org/10.1108/IJSHE-07-2020-0277.
2. Bae TJ, Qian S, Miao C, Fiet JO. The Relationship Between Entrepreneurship Education and Entrepreneurial Intentions: A Meta-Analytic Review. Entrepreneurship: Theory Pract. 2014;38(2):217–54. https://doi.org/10.1111/etap.12095.
3. Biberhofer P, Lintner C, Bernhardt J, Rieckmann M. Facilitating work performance of sustainability-driven entrepreneurs through higher education: The relevance of competencies, values, worldviews and opportunities. Int J Entrepreneurship Innov. 2019;20(1):21–38. https://doi.org/10.1177/1465750318755881.
4. Caballero CL, Walker A, Fuller-Tyszkiewicz M. (2011). *Journal of Teaching and Learning for Graduate Employability* (Vol. 2, Number 2).

5. Christou A, Ioannou A, McQuillan D, Yiatros S. Embedding GreenComp in Entrepreneurship Education for Engineers: a Qualitative Case Study of Sustainability-Oriented Entrepreneurship Learning. Entrepreneurship Educ. 2026. https://doi.org/10.1007/s41959-026-00178-9.
6. Christou A, Yiatros S, Ioannou A. Eco-preneurship education and its role in developing sustainability and entrepreneurship competences and eco-preneurial intentions. Sustainable Technol Entrepreneurship. 2026;5(1). https://doi.org/10.1016/j.stae.2025.100120.
7. Cohen B, Winn MI. Market imperfections, opportunity and sustainable entrepreneurship. J Bus Ventur. 2007;22(1):29–49. https://doi.org/10.1016/j.jbusvent.2004.12.001.
8. Dean TJ, McMullen JS. Toward a theory of sustainable entrepreneurship: Reducing environmental degradation through entrepreneurial action. J Bus Ventur. 2007;22(1):50–76. https://doi.org/10.1016/j.jbusvent.2005.09.003.
9. Del Vecchio P, Secundo G, Mele G, Passiante G. Sustainable entrepreneurship education for circular economy: emerging perspectives in Europe. Int J Entrepreneurial Behav Res. 2021;27(8):2096–124. https://doi.org/10.1108/IJEBR-03-2021-0210.
10. Diepolder CS, Weitzel H, Huwer J. (2021). Competence frameworks of sustainable entrepreneurship: A systematic review. In *Sustainability (Switzerland)* (Vol. 13, Number 24). MDPI. https://doi.org/10.3390/su132413734
11. Dul J. Necessary Condition Analysis (NCA). Organizational Res Methods. 2016;19(1):10–52. https://doi.org/10.1177/1094428115584005.
12. Dul J, van der Laan E, Kuik R. A Statistical Significance Test for Necessary Condition Analysis. Organizational Res Methods. 2020;23(2):385–95. https://doi.org/10.1177/1094428118795272.
13. Foucrier T, Wiek A. A process-oriented framework of competencies for sustainability entrepreneurship. Sustain (Switzerland). 2019;11(24). https://doi.org/10.3390/su11247250.
14. Gamarra-Chávez CA, Fernández-Pérez V, Fernández-Pascual R. Is sustainable entrepreneurship education effective in encouraging sustainable entrepreneurial intentions? The role of university students' prior experience. Int J Manage Educ. 2026;24(2). https://doi.org/10.1016/j.ijme.2026.101419.
15. Hair JF, Hult GTM, ., Ringle CM, Sarstedt M. A primer on partial least squares structural equation modeling (PLS-SEM). 3rd ed. SAGE Publications, Inc; 2022.
16. Hasan M, Supatminingsih T, Tahir T, M. I., Said Ahmad MI. Entrepreneurship education in higher education: Can we create entrepreneurial readiness through the power of agility in Generation Z students? Int J Manage Educ. 2025;23(3). https://doi.org/10.1016/j.ijme.2025.101264.
17. Hasan M, Tiara Hutamy E, Supatminingsih T, Ahmad MIS, Aeni N, Dzhelilov AA. The role of entrepreneurship education in the entrepreneurial readiness of generation Z students: why do digital business literacy and financial literacy matter? Cogent Educ. 2024;11(1). https://doi.org/10.1080/2331186X.2024.2371178.
18. Henseler J, Ringle CM, Sarstedt M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. J Acad Mark Sci. 2015;43(1):115–35.

https://doi.org/10.1007/s11747-014-0403-8.

19. Henseler J, Ringle CM, Sarstedt M. Testing measurement invariance of composites using partial least squares. Int Mark Rev. 2016;33(3):405–31. https://doi.org/10.1108/IMR-09-2014-0304.
20. Hörisch J, Fokuhl M, Buhr M, Dickel P. From Environmentalist to Ecopreneur? Target Groups and Role Models as Key Elements in Sustainable Entrepreneurship Education. Sustain Dev. 2025. https://doi.org/10.1002/sd.70307.
21. Joensuu-Salo S, Viljamaa A, Varamäki E. (2022). *Sustainable Entrepreneurs of the Future: The Interplay between Educational Context, Sustainable Entrepreneurship Competence, and Entrepreneurial Intentions*. https://doi.org/10.3390/admsci
22. Klapper RG, Fayolle A. A transformational learning framework for sustainable entrepreneurship education: The power of Paulo Freire's educational model. Int J Manage Educ. 2023;21(1). https://doi.org/10.1016/j.ijme.2022.100729.
23. Kock N. Common Method Bias in PLS-SEM. Int J E-Collaboration. 2015;11(4):1–10. https://doi.org/10.4018/ijec.2015100101.
24. Kock N, Hadaya P. Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. Inform Syst J. 2018;28(1):227–61. https://doi.org/10.1111/isj.12131.
25. Lans T, Blok V, Wesselink R. Learning apart and together: Towards an integrated competence framework for sustainable entrepreneurship in higher education. J Clean Prod. 2014;62:37–47. https://doi.org/10.1016/j.jclepro.2013.03.036.
26. Lopes JM, Suchek N, Gomes S. (2023). The antecedents of sustainability-oriented entrepreneurial intentions: An exploratory study of Angolan higher education students. *Journal of Cleaner Production*, *391*. https://doi.org/10.1016/j.jclepro.2023.136236
27. Martin BC, McNally JJ, Kay MJ. Examining the formation of human capital in entrepreneurship: A meta-analysis of entrepreneurship education outcomes. J Bus Ventur. 2013;28(2):211–24. https://doi.org/10.1016/j.jbusvent.2012.03.002.
28. Nitzl C, Roldan JL, Cepeda G. Mediation analysis in partial least squares path modelling, Helping researchers discuss more sophisticated models. Industrial Manage Data Syst. 2016;116(9):1849–64. https://doi.org/10.1108/IMDS-07-2015-0302.
29. Pascucci T, Cardella GM, Hernàndez-Sànchez B, Sànchez-Garcìa JC. Environmental Sensitivity to Form a Sustainable Entrepreneurial Intention. Sustain (Switzerland). 2022;14(16). https://doi.org/10.3390/su141610398.
30. Ploum L, Blok V, Lans T, Omta O. Exploring the relation between individual moral antecedents and entrepreneurial opportunity recognition for sustainable development. J Clean Prod. 2018;172:1582–91. https://doi.org/10.1016/j.jclepro.2017.10.296.
31. Richter NF, Schubring S, Hauff S, Ringle CM, Sarstedt M. When predictors of outcomes are necessary: guidelines for the combined use of PLS-SEM and NCA. Industrial Manage Data Syst. 2020;120(12):2243–67. https://doi.org/10.1108/IMDS-11-2019-0638.

32. Rosário AT, Raimundo R. (2024). Sustainable Entrepreneurship Education: A Systematic Bibliometric Literature Review. In *Sustainability (Switzerland)* (Vol. 16, Number 2). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/su16020784
33. Sarstedt M, Henseler J, Ringle CM. Multigroup analysis in partial least squares (PLS) path modeling: Alternative methods and empirical results. Adv Int Mark. 2011;22:195–218. https://doi.org/10.1108/S1474-7979(2011)0000022012.
34. Schaltegger S, Wagner M. Sustainable entrepreneurship and sustainability innovation: Categories and interactions. Bus Strategy Environ. 2011;20(4):222–37. https://doi.org/10.1002/bse.682.
35. Shepherd DA, Patzelt H. The New Field of Sustainable Entrepreneurship: Studying Entrepreneurial Action Linking What Is to Be Sustained With What Is to Be Developed. Entrepreneurship: Theory Pract. 2011;35(1):137–63. https://doi.org/10.1111/j.1540-6520.2010.00426.x.
36. Shmueli G, Ray S, Estrada V, J. M., Chatla SB. The elephant in the room: Predictive performance of PLS models. J Bus Res. 2016;69(10):4552–64. https://doi.org/10.1016/j.jbusres.2016.03.049.
37. Shmueli G, Sarstedt M, Hair JF, Cheah JH, Ting H, Vaithilingam S, Ringle CM. Predictive model assessment in PLS-SEM: guidelines for using PLSpredict. Eur J Mark. 2019;53(11):2322–47. https://doi.org/10.1108/EJM-02-2019-0189.
38. Terán-Yépez E, Marín-Carrillo GM, Casado-Belmonte M del P., de Capobianco-Uriarte M. las M. (2020). Sustainable entrepreneurship: Review of its evolution and new trends. *Journal of Cleaner Production*, *252*. https://doi.org/10.1016/j.jclepro.2019.119742
39. Unger JM, Rauch A, Frese M, Rosenbusch N. Human capital and entrepreneurial success: A meta-analytical review. J Bus Ventur. 2011;26(3):341–58. https://doi.org/10.1016/j.jbusvent.2009.09.004.
40. Vuorio AM, Puumalainen K, Fellnhofer K. Drivers of entrepreneurial intentions in sustainable entrepreneurship. Int J Entrepreneurial Behav Res. 2018;24(2):359–81. https://doi.org/10.1108/IJEBR-03-2016-0097.
41. Wiek A, Withycombe L, Redman CL. (2011). Key competencies in sustainability: A reference framework for academic program development. In *Sustainability Science* (Vol. 6, Number 2, pp. 203–218). https://doi.org/10.1007/s11625-011-0132-6
42. Yasir N, Mahmood N, Mehmood HS, Babar M, Irfan M, Liren A. Impact of environmental, social values and the consideration of future consequences for the development of a sustainable entrepreneurial intention. Sustain (Switzerland). 2021;13(5):1–20. https://doi.org/10.3390/su13052648.
43. Zhao X, Lynch JG, Chen Q. Reconsidering Baron and Kenny: Myths and truths about mediation analysis. J Consum Res. 2010;37(2):197–206. https://doi.org/10.1086/651257.

Figures

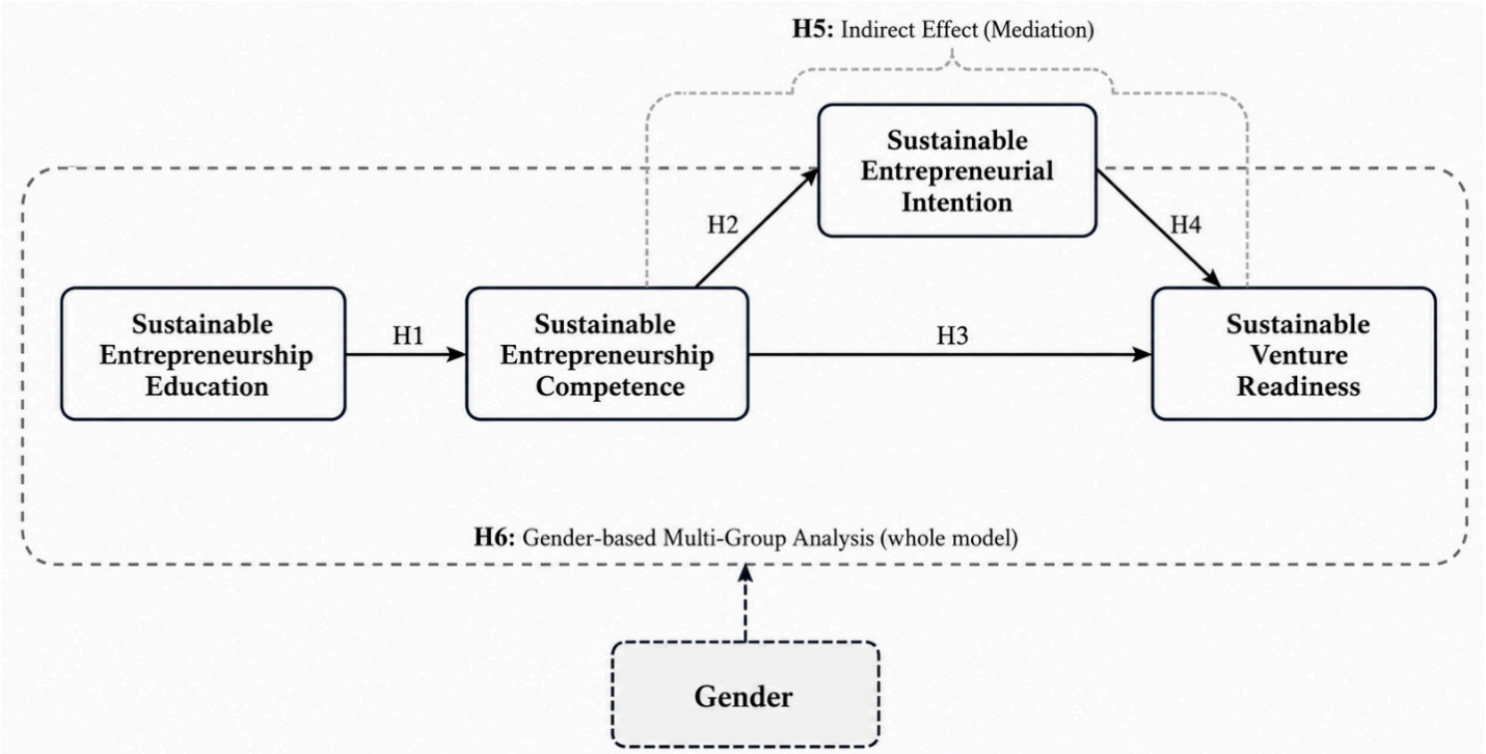


Figure 1

Conceptual framework

Source. Author's own conceptualisation based on the reviewed literature.

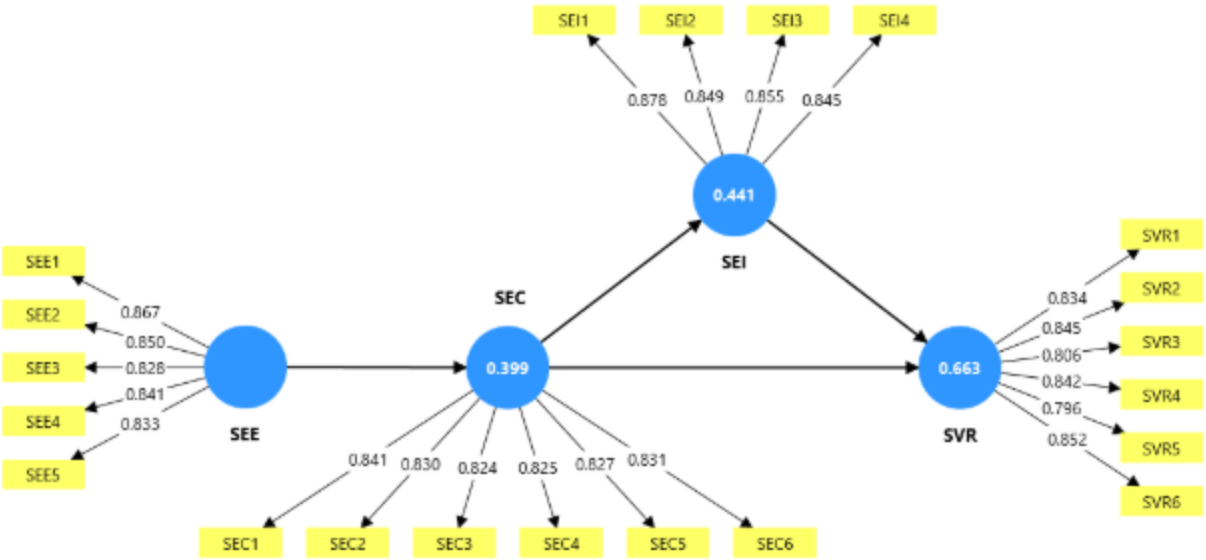


Figure 2

Measurement Model

Source. Author's own output based on SmartPLS analysis.

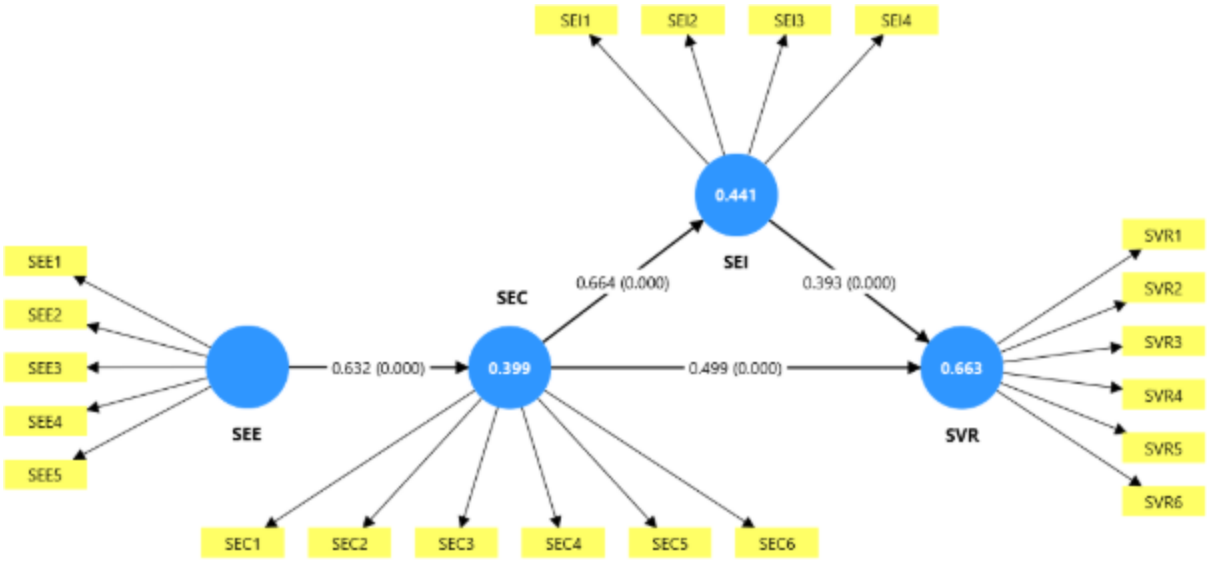


Figure 3

Structural Model

Source. Author's own output based on SmartPLS analysis.

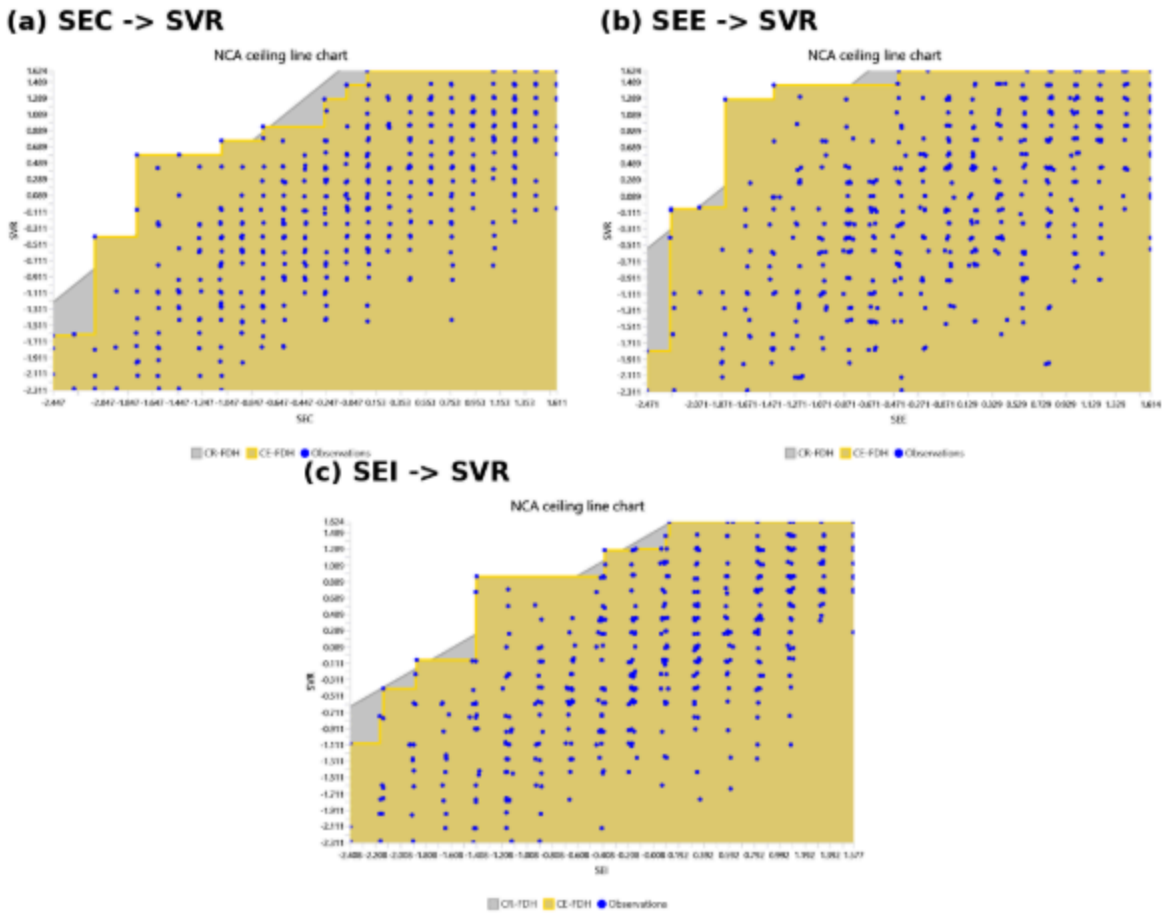


Figure 4

NCA ceiling line charts for necessary conditions of Sustainable Venture Readiness

Source. Author's own output based on SmartPLS/NCA analysis.

Supplementary Files

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- AppendixinstitutionalEthicsCommittee.pdf