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Entrepreneurship Education and Digital Entrepreneurial Intention among University Students: An Integrated Approach Using PLS-SEM and Necessary Condition Analysis

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Abstract. This study examines how entrepreneurship education shapes digital entrepreneurial intention by integrating the Theory of Planned Behavior with Partial Least Squares Structural Equation Modeling (PLS-SEM) and Necessary Condition Analysis (NCA). Data from 400 university students in Ho Chi Minh City, Vietnam, were analyzed. PLS-SEM showed that entrepreneurship education directly increased digital entrepreneurial intention (β =0.193) and strongly predicted attitude (β =0.538), subjective norms (β =0.491), and perceived behavioral control (β =0.475), with all p<0.001. Attitude (β =0.260), subjective norms (β =0.208), and perceived behavioral control (β =0.255) significantly predicted intention and mediated the education–intention relationship (β =0.140, 0.102, and 0.121, respectively). NCA identified medium necessity effects ranging from 0.129 to 0.174. Achieving 90% digital entrepreneurial intention required minimum levels of 14.50% for attitude, 18.25% for education, 25.75% for perceived behavioral control, and 34.50% for subjective norms, demonstrating complementary sufficiency and necessity mechanisms.

1. Introduction

Digital transformation has changed the conditions under which new ventures are created, operated, and scaled. Digital platforms, artificial intelligence, socisal media, and data-driven technologies have reduced many traditional barriers to market entry and enabled individuals to pursue entrepreneurial opportunities with fewer physical and financial resources [1,2]. These changes are particularly relevant to university students, who are generally more exposed to emerging technologies and increasingly view digital business as a viable career option. Vietnam provides an important setting for this development. The rapid expansion of its digital economy, the growing use of online platforms, and national efforts to promote entrepreneurship have created favorable conditions for the creation of digitally enabled ventures [3,4]. In Vietnam, Ho Chi Minh City is a

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particularly relevant context because of its concentration of universities, entrepreneurial activity, technology businesses, and young, digitally active populations. Universities in the city have increasingly incorporated entrepreneurship courses, startup competitions, mentoring activities, and innovation programs into student development. However, providing entrepreneurship education does not necessarily mean that students will develop a corresponding intention to become digital entrepreneurs. The more important question concerns how education is translated into such an intention.

Entrepreneurship education has long been regarded as an important means of developing entrepreneurial knowledge, competencies, and motivation. Its relevance has become even greater as entrepreneurship increasingly takes place in technology-intensive environments. Recent research generally supports a positive association between entrepreneurship education and digital entrepreneurial intention, although the mechanisms underlying this relationship remain less settled. Entrepreneurship education has been linked to digital entrepreneurial intention through creativity, entrepreneurial alertness, digital entrepreneurial knowledge, entrepreneurial competencies, social media usage, and digital entrepreneurial self-efficacy [5–9]. Other studies have treated entrepreneurship education as a contextual condition that strengthens or weakens the effects of individual characteristics and technological factors on digital entrepreneurial intention [4, 10]. These different specifications indicate that the contribution of entrepreneurship education is established, but its theoretical position in the formation of digital entrepreneurial intention remains fragmented.

The Theory of Planned Behavior (TPB) provides a useful basis for resolving this issue. According to TPB, behavioral intention is primarily determined by attitude, subjective norms, and perceived behavioral control [11]. Existing evidence nevertheless leaves several issues unresolved. Studies of digital entrepreneurial intention have increasingly introduced new psychological and technological constructs, while comparatively less attention has been given to examining entrepreneurship education systematically as an antecedent of the three original TPB mechanisms. Nguyen and Nguyen [4], for example, incorporated TPB into digital entrepreneurship research but primarily examined digital entrepreneurship education as a moderator. Their results showed that education did not uniformly strengthen the effects of attitude, subjective norms, and other predictors on digital entrepreneurial intention, while its moderation of the relationship between perceived behavioral control and intention was negative. Other studies have shifted attention toward self efficacy, creativity, alertness, digital knowledge, social media, and artificial intelligence rather than clarifying how education operates through the complete TPB process [6, 10, 12, 13]. A recent Vietnamese study by Ha, et al. [3] moves closer to this issue by showing that entrepreneurship education indirectly influences electronic entrepreneurial intention through attitude, subjective norms, perceived behavioral control, and social media entrepreneurial usage. However, that model focuses on electronic entrepreneurship and emphasizes indirect educational pathways without simultaneously examining whether entrepreneurship education retains a direct influence on

digital entrepreneurial intention. Consequently, the extent to which entrepreneurship education shapes digital entrepreneurial intention directly and through the three canonical TPB mechanisms remains insufficiently resolved.

A further limitation concerns the analytical logic adopted in previous studies. Research in this area has predominantly relied on regression, structural equation modeling, or PLS SEM to estimate the magnitude and significance of relationships among entrepreneurship education, psychological factors, and entrepreneurial intention [4,7,8,14]. Such approaches are well-suited to determining whether an increase in one construct is associated with an increase in another and to assessing direct and indirect effects. They do not, however, establish whether a certain minimum level of education, attitude, subjective norms, or perceived behavioral control is indispensable for achieving a high level of digital entrepreneurial intention. This distinction is important because a factor may have a significant average effect without being necessary, while another factor with a modest net effect may constitute a critical bottleneck. Necessary Condition Analysis addresses this issue by identifying conditions that must be met at specific levels for a desired outcome to occur [15]. Combining PLS-SEM with NCA, therefore, offers a more complete assessment of both effect-based relationships and necessary conditions.

Against this background, the present study examines university students in Ho Chi Minh City and investigates how entrepreneurship education shapes digital entrepreneurial intention. Drawing on TPB, the study proposes that entrepreneurship education directly influences digital entrepreneurial intention and indirectly influences it through attitude, subjective norms, and perceived behavioral control. PLS-SEM is employed to assess the proposed direct and mediating relationships. At the same time, NCA is used to determine whether entrepreneurship education and the three TPB mechanisms are necessary conditions for achieving a high level of digital entrepreneurial intention. This approach contributes to digital entrepreneurship research by clarifying the theoretical role of entrepreneurship education within TPB and by distinguishing factors that significantly promote digital entrepreneurial intention from those that students must possess at minimum levels for strong digital entrepreneurial intention to emerge.

2. Literature Review

2.1. **Theory of Planned Behavior (TPB).** The TPB provides a well-established framework for explaining how individuals form intentions toward a particular behavior [11]. In digital entrepreneurship, TPB suggests that digital entrepreneurial intention is primarily shaped by attitude toward digital entrepreneurship, subjective norms, and perceived behavioral control [4,13]. Recent studies confirm that these three cognitive mechanisms remain relevant to explaining entrepreneurial intention in technology-enabled contexts, although their effects may vary with educational and contextual conditions [3,4]. Entrepreneurship education can therefore be positioned as an external antecedent that shapes students' evaluations of digital entrepreneurship, perceived social support, and perceived capability to perform entrepreneurial activities. Accordingly, TPB

provides an appropriate theoretical lens for explaining how entrepreneurship education is translated into digital entrepreneurial intention through attitude, subjective norms, and perceived behavioral control [3,13].

2.2. **Entrepreneurship education and digital entrepreneurial intention.** Entrepreneurship education provides students with the knowledge, skills, and practical exposure required to recognize and exploit entrepreneurial opportunities. In digital settings, these learning experiences can improve students' understanding of digital business models and strengthen their readiness to pursue technology enabled ventures. Recent studies show that entrepreneurship education is positively associated with digital entrepreneurial intention, particularly when educational activities incorporate practical and digital elements [6,12,16]. Accordingly, students who receive stronger entrepreneurship education are more likely to consider digital entrepreneurship as a viable career option.

H1. Entrepreneurship education positively influences digital entrepreneurial intention.

2.3. **Entrepreneurship education and attitude toward digital entrepreneurship.** Entrepreneurship education can shape how students evaluate digital entrepreneurship by improving their understanding of its opportunities, benefits, and career potential. Exposure to entrepreneurial knowledge and practical activities enables students to form more favorable beliefs about starting and managing digital ventures. Recent evidence indicates that entrepreneurship education contributes positively to entrepreneurial attitudes, including in technology enabled entrepreneurial contexts [3,17]. Therefore, stronger entrepreneurship education is expected to foster a more positive attitude toward digital entrepreneurship.

H2. Entrepreneurship education positively influences attitude toward digital entrepreneurship.

2.4. **Entrepreneurship education and subjective norms.** Entrepreneurship education also creates a social environment in which students interact with lecturers, peers, mentors, and entrepreneurial role models. These interactions can normalize entrepreneurship as a career choice and increase students' perceptions that important referents support entrepreneurial activities. Ha, et al. [3] found that entrepreneurship education positively influences subjective norms among Vietnamese university students. Thus, entrepreneurship education can strengthen perceived social approval toward pursuing digital entrepreneurship.

H3. Entrepreneurship education positively influences subjective norms toward digital entrepreneurship.

2.5. **Entrepreneurship education and perceived behavioral control.** Entrepreneurship education can strengthen students' perceived behavioral control by developing knowledge and skills related to opportunity recognition, business planning, resource mobilization, and digital business operations. Such learning experiences reduce perceived barriers and make entrepreneurial activities appear more manageable. Recent studies indicate that entrepreneurship education enhances

students' perceptions of entrepreneurial capability and control, particularly when education incorporates practical and technology related competencies [3, 18]. Therefore, entrepreneurship education is expected to enhance students' perceived ability to engage in digital entrepreneurship.

H4. Entrepreneurship education positively influences perceived behavioral control toward digital entrepreneurship.

2.6. **Attitude toward digital entrepreneurship and digital entrepreneurial intention.** Attitude reflects an individual's overall evaluation of engaging in digital entrepreneurship. When students perceive digital entrepreneurship as attractive, valuable, and consistent with their career goals, they are more likely to develop stronger intentions to pursue digital ventures. Empirical studies consistently identify attitude as an important predictor of digital entrepreneurial intention among university students [3, 4, 7]. Entrepreneurship education can also improve these evaluations by increasing students' understanding of entrepreneurial opportunities and outcomes. Consequently, attitude represents an important psychological mechanism through which entrepreneurship education can be translated into digital entrepreneurial intention. This indirect mechanism is also supported by Ha, et al. [3], who found a significant mediating role of entrepreneurial attitude in the relationship between entrepreneurship education and electronic entrepreneurial intention.

H5. Attitude toward digital entrepreneurship positively influences digital entrepreneurial intention.

H8. Attitude toward digital entrepreneurship mediates the relationship between entrepreneurship education and digital entrepreneurial intention.

2.7. **Subjective norms and digital entrepreneurial intention.** Subjective norms reflect the perceived approval of important referents such as family members, friends, lecturers, and peers. When these groups support digital entrepreneurship, students may perceive such a career choice as more socially acceptable and legitimate, thereby strengthening their intention to engage in digital ventures. Recent evidence supports the relevance of subjective norms in explaining entrepreneurial intentions within digital contexts [3, 4]. Entrepreneurship education may reinforce this mechanism by creating an academic environment that encourages entrepreneurial activities and exposes students to supportive social networks. Subjective norms can therefore transmit part of the influence of entrepreneurship education to digital entrepreneurial intention, consistent with the indirect relationship reported by Ha, et al. [3].

H6. Subjective norms positively influence digital entrepreneurial intention.

H9. Subjective norms mediate the relationship between entrepreneurship education and digital entrepreneurial intention.

2.8. **Perceived behavioral control and digital entrepreneurial intention.** Perceived behavioral control reflects the extent to which students believe they possess the ability, resources, and control necessary to engage in digital entrepreneurship. Students who perceive greater control over entrepreneurial tasks are more likely to consider digital venture creation feasible and consequently develop stronger digital entrepreneurial intention. Recent studies consistently demonstrate that

perceived behavioral control is a central determinant of entrepreneurial intention in digitally intensive contexts, where individuals must perceive themselves as capable of handling technological, financial, and operational requirements [3,4,19,20]. Entrepreneurship education can enhance this perception by equipping students with relevant knowledge, practical skills, and greater familiarity with entrepreneurial processes. Perceived behavioral control therefore provides another mechanism through which entrepreneurship education can strengthen digital entrepreneurial intention. Ha, et al. [3] similarly found that perceived behavioral control significantly transmits the effect of entrepreneurship education to electronic entrepreneurial intention.

H7. Perceived behavioral control positively influences digital entrepreneurial intention.

H10. Perceived behavioral control mediates the relationship between entrepreneurship education and digital entrepreneurial intention.

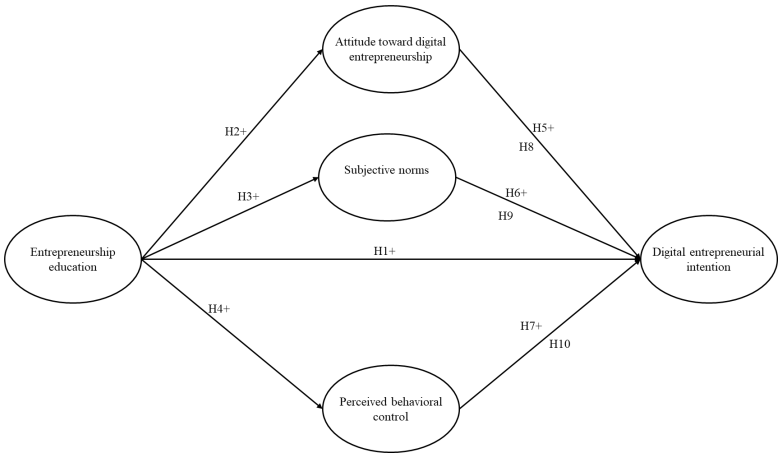


FIGURE 1. Research model.

3. METHODOLOGY

3.1. **Measurement of Constructs.** All constructs were measured using multi-item scales adapted from established studies and modified to fit the context of digital entrepreneurship among university students in Ho Chi Minh City. A five point Likert scale ranging from 1= "strongly disagree", to 5 = "strongly agree", was used for all measurement items. Entrepreneurship education, attitude toward digital entrepreneurship, subjective norms, and perceived behavioral control were adapted from [4]. Digital entrepreneurial intention was measured using items adapted from [10].

3.2. **Data Collection and Sample Screening.** Primary data were collected through an online questionnaire developed using Google Forms. The survey targeted university students currently studying in Ho Chi Minh City because this group represents an appropriate population for examining digital entrepreneurial intention. University students are increasingly exposed to entrepreneurship education, digital technologies, online business platforms, and entrepreneurial support activities, which allow them to meaningfully evaluate the constructs included in the research model.

The questionnaire link was distributed to university students in Ho Chi Minh City. Participation was voluntary, and respondents completed the questionnaire based on their perceptions of entrepreneurship education, attitude toward digital entrepreneurship, subjective norms, perceived behavioral control, and digital entrepreneurial intention.

A total of 448 responses were initially collected. Before conducting the main statistical analysis, the dataset was screened to improve data quality. Responses were examined for missing information, duplicate submissions, repetitive response patterns in which the same option was selected on most questionnaire items, and other indications of inattentive responses. Based on these screening criteria, 48 responses were excluded from the dataset.

After the data cleaning process, 400 valid responses remained and were retained for the final analysis. Therefore, the effective response sample used to test the measurement and structural models consisted of 400 university students. This sample size exceeds the minimum requirement for PLS SEM and provides an adequate basis for estimating the proposed relationships among the constructs [21].

As shown in Table 1, female respondents accounted for 56.2% of the sample, while male respondents represented 43.8%. Regarding year of study, third year students constituted the largest group at 33.2%, followed by students in their fourth year or above at 27.2%. In terms of academic background, 41.5% of respondents studied Economics or Business Administration, followed by Marketing or E commerce at 22.2%, other disciplines at 20.0%, and Information Technology or Information Systems at 16.3%. Notably, 60.0% of respondents had taken or were currently taking an entrepreneurship course, while 45.3% reported prior online business experience. Overall, the sample included students with varying academic backgrounds and meaningful exposure to entrepreneurship education and digital business activities, making it appropriate for examining digital entrepreneurial intention.

Table 1. Demographic profile of respondents

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	175	43.8
	Female	225	56.2
Year of study	First year	55	13.8
	Second year	103	25.8
	Third year	133	33.2
	Fourth year or above	109	27.2
Field of study	Economics/Business Administration	166	41.5
	Marketing/E commerce	89	22.2
	Information Technology/Information Systems	65	16.3
	Others	80	20.0
Entrepreneurship course experience	Taken/currently taking	240	60.0
	Not taken	160	40.0
Online business experience	Yes	181	45.3
	No	219	54.7

3.3. **Data Analysis.** PLS-SEM and Necessary Condition Analysis were jointly employed to examine the proposed research model. PLS-SEM was used to estimate the direct and indirect relationships among the latent constructs and to assess the model's explanatory and predictive performance. In parallel, NCA was applied to determine whether entrepreneurship education, attitude toward digital entrepreneurship, subjective norms, and perceived behavioral control represent necessary conditions for achieving high levels of digital entrepreneurial intention. Combining these two approaches enables the study to distinguish between factors that significantly contribute to digital entrepreneurial intention and conditions that must reach a minimum level for a high level of intention to occur. All PLS, SEM, and NCA procedures were performed in SmartPLS 4.1.

4. Results

4.1. **Measurement model.** The measurement model was assessed for indicator reliability, internal consistency, and convergent validity. As shown in Table 2, all outer loadings exceeded the recommended threshold of 0.70, ranging from 0.718 to 0.814. Cronbach's alpha values ranged from 0.749 to 0.790, while rho_A values ranged from 0.752 to 0.795. Composite reliability values ranged from 0.842 to 0.864, exceeding the recommended threshold of 0.70. In addition, the AVE values ranged from 0.571 to 0.613, all above the threshold of 0.50. Therefore, all constructs demonstrated satisfactory indicator reliability, internal consistency reliability, and convergent validity [21].

Based on Table 3, all Heterotrait-Monotrait (HTMT) values among the constructs range from 0.614 to 0.751. Since every value is well below the recommended conservative threshold of 0.85, discriminant validity is strongly established, indicating that all latent variables in the model (ATB, DEI, EE, PBC, and SN) are truly distinct from one another and measure different concepts without overlapping [22].

Table 3. HTMT values

	ATB	**DEI**	**EE**	**PBC**	**SN**
ATB					
DEI	0.746				
EE	0.695	0.721			
PBC	0.635	0.751	0.617		
SN	0.614	0.728	0.637	0.719	

4.2. **Structural model.** The structural model results show that all hypothesized direct relationships were positive and statistically significant (see Table 4 and Figure 2). Entrepreneurship education was positively associated with digital entrepreneurial intention ($\beta = 0.193$, $p < 0.001$), supporting H1. Entrepreneurship education was also positively associated with attitude toward digital entrepreneurship ($\beta = 0.538$, $p < 0.001$), subjective norms ($\beta = 0.491$, $p < 0.001$), and perceived behavioral control ($\beta = 0.475$, $p < 0.001$), supporting H2 to H4.

TABLE 2. Measurement model assessment

Construct	Item	Outer loading	Cronbach's α	rho_A	CR	AVE
Attitude toward digital entrepreneurship (ATB)	ATB1	0.718	0.788	0.795	0.863	0.612
	ATB2	0.797				
	ATB3	0.800				
	ATB4	0.810				
Digital entrepreneurial intention (DEI)	DEI1	0.761	0.790	0.793	0.864	0.613
	DEI2	0.814				
	DEI3	0.797				
	DEI4	0.758				
Entrepreneurship education (EE)	EE1	0.724	0.749	0.752	0.842	0.571
	EE2	0.760				
	EE3	0.793				
	EE4	0.744				
Perceived behavioral control (PBC)	PBC1	0.767	0.787	0.788	0.862	0.610
	PBC2	0.809				
	PBC3	0.770				
	PBC4	0.776				
Subjective norms (SN)	SN1	0.783	0.780	0.784	0.858	0.602
	SN2	0.754				
	SN3	0.801				
	SN4	0.765				

Consistent with TPB, attitude (β = 0.260, p < 0.001), subjective norms (β = 0.208, p < 0.001), and perceived behavioral control (β = 0.255, p < 0.001) were all positively associated with digital entrepreneurial intention. Thus, H5 to H7 were supported.

The three specific indirect effects were also statistically significant. Entrepreneurship education was indirectly associated with digital entrepreneurial intention through attitude (β = 0.140, p < 0.001), subjective norms (β = 0.102, p < 0.001), and perceived behavioral control (β = 0.121, p < 0.001). The bias corrected confidence intervals for all three indirect effects excluded zero, supporting H8 to H10.

TABLE 4. Structural model

Hypothesis	Relationship	β	STDEV	t value	p value	95% BC CI	Decision
H1	EE → DEI	0.193	0.042	4.570	<0.001	[0.107, 0.274]	Supported
H2	EE → ATB	0.538	0.035	15.405	<0.001	[0.464, 0.602]	Supported
H3	EE → SN	0.491	0.036	13.457	<0.001	[0.409, 0.555]	Supported
H4	EE → PBC	0.475	0.039	12.323	<0.001	[0.398, 0.549]	Supported
H5	ATB → DEI	0.260	0.045	5.853	<0.001	[0.171, 0.347]	Supported
H6	SN → DEI	0.208	0.042	4.937	<0.001	[0.126, 0.291]	Supported
H7	PBC → DEI	0.255	0.042	6.083	<0.001	[0.170, 0.335]	Supported
H8	EE → ATB → DEI	0.140	0.026	5.394	<0.001	[0.092, 0.195]	Supported
H9	EE → SN → DEI	0.102	0.023	4.511	<0.001	[0.060, 0.149]	Supported
H10	EE → PBC → DEI	0.121	0.022	5.452	<0.001	[0.081, 0.168]	Supported

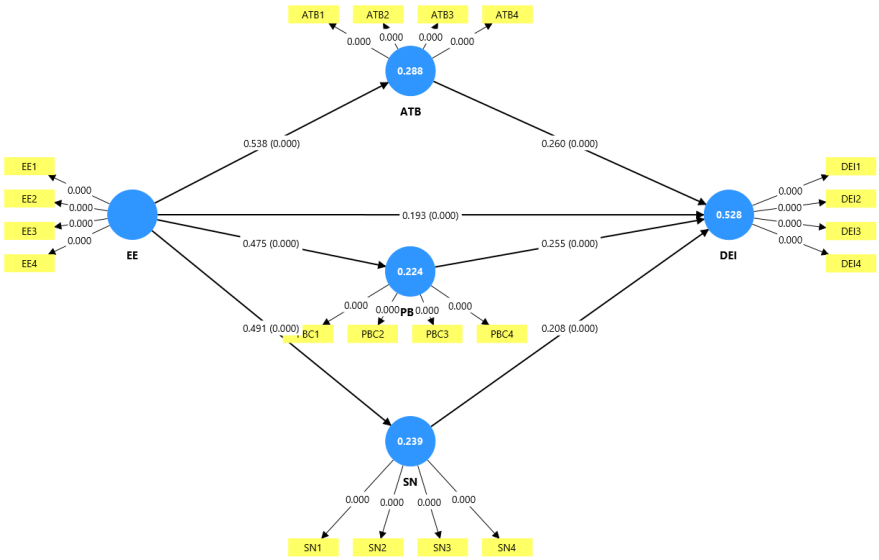


FIGURE 2. Structural model.

4.3. **Necessary Condition Analysis.** The NCA results indicate that all four conditions exhibited meaningful necessity effects on digital entrepreneurial intention. Based on the CE FDH results, subjective norms showed the largest effect size with d=0.174, followed by entrepreneurship education with d=0.159, attitude toward digital entrepreneurship with d=0.146, and perceived behavioral control with d=0.129. All effect sizes were within the medium range. The CR FDH results were highly consistent with the CE FDH estimates, with effect sizes ranging from 0.117 to 0.161 and ceiling accuracies above 97%. Overall, the findings suggest that deficiencies in these conditions may constrain the attainment of high levels of digital entrepreneurial intention, with subjective norms showing the strongest necessity constraint among the four conditions.

TABLE 5. Necessary Condition Analysis results

Condition	CE-FDH d	Effect size	CE-FDH accuracy (%)	CR-FDH d	CR-FDH accuracy (%)
Attitude toward digital entrepreneurship (ATB)	0.146	Medium	100.00	0.150	97.75
Entrepreneurship education (EE)	0.159	Medium	100.00	0.153	98.00
Perceived behavioral control (PBC)	0.129	Medium	100.00	0.117	98.00
Subjective norms (SN)	0.174	Medium	100.00	0.161	98.25

The bottleneck analysis specifies the minimum levels of each condition required to attain different levels of digital entrepreneurial intention. At relatively low levels of DEI, some conditions were not necessary. However, the required levels increased progressively as the targeted DEI level became higher. For example, achieving 90% of the observed DEI range required minimum percentile levels of 14.50 for attitude, 18.25 for entrepreneurship education, 25.75 for perceived behavioral control, and 34.50 for subjective norms. At the maximum observed level of DEI, the requirements increased substantially to 52.25, 39.25, 75.75, and 34.50, respectively. Notably, perceived behavioral control became the most restrictive bottleneck at the highest DEI level, indicating that very high digital entrepreneurial intention may not be attainable when students perceive insufficient control over entrepreneurial activities.

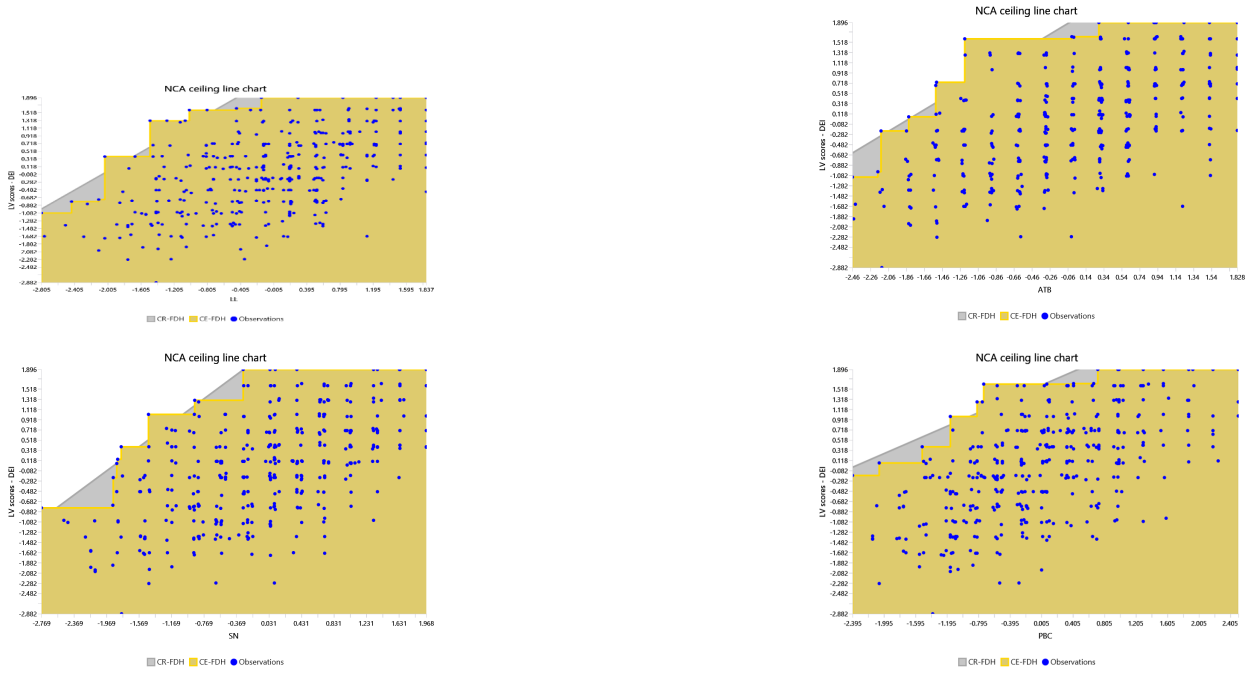


FIGURE 3. NCA ceiling line plots

Table 6. CE-FDH bottleneck analysis for digital entrepreneurial intention

DEI level	ATB	EE	PBC	SN
40%	1.25	0.75	NN	NN
50%	1.25	2.00	NN	3.00
60%	3.25	2.00	1.25	3.25
70%	7.25	6.75	10.50	9.25
80%	14.50	6.75	10.50	9.25
90%	14.50	18.25	25.75	34.50
100%	52.25	39.25	75.75	34.50

5. Discussion of Findings

The findings support the proposed TPB based model and reveal complementary insights from PLS SEM and NCA. Entrepreneurship education was positively associated with digital entrepreneurial intention and all three TPB mechanisms, while attitude, subjective norms, and perceived behavioral control were positively associated with intention. The significant indirect effects further indicate that entrepreneurship education operates both directly and through the psychological mechanisms proposed by TPB.

First, entrepreneurship education was positively associated with digital entrepreneurial intention, supporting H1. This finding is consistent with Liang et al. [6], who showed that entrepreneurship education, particularly practice oriented education, promotes digital entrepreneurial intention, and with Duong, et al. [12], who reported a positive relationship between digital entrepreneurship education and intention through digital entrepreneurial self efficacy. The present study extends this evidence by showing that entrepreneurship education retains a direct association with digital entrepreneurial intention even when the three canonical TPB mechanisms are simultaneously considered

Second, entrepreneurship education was positively associated with attitude, subjective norms, and perceived behavioral control, supporting H2 to H4. Its strongest association was with attitude, suggesting that educational exposure is particularly relevant to how students evaluate digital entrepreneurship as a career option. These results are consistent with Ha, et al. [3], who found that entrepreneurship education significantly influences attitude, subjective norms, and perceived behavioral control in the Vietnamese electronic entrepreneurship context. However, the strong education to attitude relationship contrasts with Lopes, et al. [13], who found no significant effect of digital entrepreneurship education on innovative digital attitude. This difference may reflect the distinction between general evaluations of digital entrepreneurship and attitudes specifically oriented toward digital innovation.

Third, attitude, subjective norms, and perceived behavioral control were all positively associated with digital entrepreneurial intention, supporting H5 to H7. Attitude showed the strongest relationship, followed closely by perceived behavioral control, whereas subjective norms had a

comparatively weaker but still significant association. This pattern is consistent with Nguyen and Nguyen [4], who confirmed the relevance of TPB predictors for digital entrepreneurial intention among Vietnamese students, and with Vu, et al. [7], who identified attitude as an important predictor of digital entrepreneurial intention. These findings suggest that students are more inclined toward digital entrepreneurship when they both evaluate it positively and perceive themselves as capable of undertaking digitally enabled entrepreneurial activities.

The mediation results further clarify how entrepreneurship education is translated into digital entrepreneurial intention. Attitude produced the strongest indirect effect, followed by perceived behavioral control and subjective norms. Since the direct relationship between entrepreneurship education and intention remained significant, the results indicate partial mediation. This finding is consistent with Duong, et al. [12], who identified digital entrepreneurial self efficacy as a mediator, and with Ha, et al. [3], who demonstrated significant indirect effects of entrepreneurship education through attitude, subjective norms, and perceived behavioral control. Thus, entrepreneurship education appears to influence digital entrepreneurial intention not only by providing knowledge and exposure but also by shaping students' evaluations, perceived social support, and perceived control.

The NCA results provide a complementary perspective. Subjective norms showed the largest CE FDH necessity effect, followed by entrepreneurship education, attitude, and perceived behavioral control, with all four effects falling within the medium range. This ordering differs from the PLS SEM results, where attitude was the strongest TPB predictor. The difference is meaningful because PLS SEM evaluates the net contribution of predictors, whereas NCA identifies conditions whose insufficient levels may constrain the achievement of a desired outcome [15]. Accordingly, subjective norms may have a relatively smaller net effect on digital entrepreneurial intention while still representing an important bottleneck for attaining high levels of intention.

The bottleneck analysis strengthens this interpretation. At 90% of the observed DEI range, all four conditions required minimum levels, with subjective norms showing the highest requirement. At the maximum observed DEI level, however, perceived behavioral control became the most restrictive bottleneck. This suggests that supportive social norms may be particularly important for attaining high digital entrepreneurial intention, whereas extremely high intention becomes difficult to achieve when students lack sufficient perceptions of capability and control. This interpretation is consistent with Vu, et al. [7], who emphasized the importance of capability related beliefs in digital entrepreneurship.

Overall, the combined findings show that the determinants of digital entrepreneurial intention should not be judged solely by the magnitude of their PLS SEM coefficients. Attitude and perceived behavioral control are relatively prominent under a sufficiency perspective, whereas subjective norms and perceived behavioral control become particularly important under necessity logic. Integrating the two approaches therefore provides a more complete explanation of how

entrepreneurship education and the TPB mechanisms contribute to, and potentially constrain, digital entrepreneurial intention.

6. Implications

6.1. **Theoretical implications.** This study makes three main theoretical contributions. First, it clarifies the role of entrepreneurship education within TPB by positioning it as an external antecedent associated with digital entrepreneurial intention, both directly and indirectly through attitude, subjective norms, and perceived behavioral control. Second, the findings reinforce the relevance of the three canonical TPB mechanisms in explaining digital entrepreneurial intention and show that they differ in relative importance across direct and mediating pathways. Third, by integrating PLS SEM with NCA, the study extends prior effect-based research by distinguishing factors that are associated with higher digital entrepreneurial intention from conditions that may constrain the attainment of high intention levels. This dual perspective provides a more nuanced understanding of how entrepreneurship education and TPB mechanisms operate in the context of digital entrepreneurship.

6.2. **Managerial Implications.** The findings provide several implications for universities, entrepreneurship educators, incubators, and other actors involved in supporting student entrepreneurship. First, entrepreneurship education should be treated as a strategic component of university career development rather than as an isolated elective course or short term extracurricular activity. The significant direct relationship between entrepreneurship education and digital entrepreneurial intention indicates that educational exposure itself remains important. Universities should therefore integrate digital entrepreneurship more systematically into curricula through courses on opportunity recognition, digital business models, platform based ventures, e commerce, digital marketing, financial planning, and the application of emerging technologies. Greater emphasis should be placed on experiential learning, including business simulations, startup projects, prototype development, market testing, pitch competitions, and collaboration with actual entrepreneurs. Such activities can help students translate abstract entrepreneurial knowledge into realistic perceptions of how digital ventures are created and managed.

Second, universities should place particular emphasis on developing favorable attitudes toward digital entrepreneurship. Among the three TPB predictors, attitude showed the strongest relationship with digital entrepreneurial intention and also represented the strongest mediating mechanism through which entrepreneurship education was associated with intention. This suggests that education should not only increase what students know about entrepreneurship but also influence how they evaluate entrepreneurship as a career option. Educators can achieve this by exposing students to realistic digital startup cases, successful and unsuccessful entrepreneurial journeys, interactions with founders, and examples of how digital ventures create economic and social value. At the same time, programs should avoid presenting entrepreneurship either as an unrealistically attractive career or as an excessively risky alternative. Instead, students should be

provided with balanced information that enables them to evaluate the benefits, challenges, and personal relevance of digital entrepreneurship. A more informed and favorable evaluation is likely to strengthen their willingness to pursue digital ventures.

Third, strengthening perceived behavioral control should constitute another major priority. Although its direct effect was slightly lower than that of attitude, perceived behavioral control showed a substantial relationship with digital entrepreneurial intention and also transmitted part of the influence of entrepreneurship education. More importantly, the NCA bottleneck analysis indicates that perceived behavioral control becomes particularly restrictive when very high levels of digital entrepreneurial intention are targeted. Universities should therefore move beyond awareness oriented entrepreneurship education and provide students with opportunities to develop concrete capabilities. Programs should include training in opportunity validation, business model development, digital platform management, customer acquisition, financial forecasting, data analysis, and the use of relevant digital tools. Access to mentoring, seed funding, incubation facilities, technical support, and multidisciplinary startup teams can further strengthen students' perceptions that they possess the resources and capabilities required to pursue digital entrepreneurship. In this sense, increasing intention requires not only making entrepreneurship desirable but also making it appear feasible and manageable.

Fourth, the role of subjective norms deserves greater managerial attention. Although subjective norms displayed the smallest direct relationship with digital entrepreneurial intention among the three TPB factors, NCA identified them as the strongest necessity constraint based on the CE FDH effect size. This finding implies that social support should not be underestimated simply because its net effect is smaller. Students may develop favorable attitudes and entrepreneurial capabilities, yet insufficient support from important referents can still restrict the attainment of high digital entrepreneurial intention. Universities should therefore create a more entrepreneurship supportive social environment by involving lecturers, mentors, alumni entrepreneurs, peers, families, and startup communities. Student startup clubs, mentor networks, entrepreneur in residence programs, alumni founder communities, and interdisciplinary entrepreneurship events can help normalize digital entrepreneurship as a legitimate career choice. Universities may also communicate more actively with students' families and other important referents to reduce concerns about entrepreneurship as an unstable or unrealistic career path.

Finally, the combined PLS SEM and NCA results suggest that universities should avoid concentrating resources on only the strongest predictor. PLS SEM indicates that attitude and perceived behavioral control are prominent drivers of digital entrepreneurial intention, whereas NCA shows that deficiencies in subjective norms, entrepreneurship education, attitude, and perceived behavioral control can constrain high levels of intention. Consequently, entrepreneurship support should be designed as an integrated system rather than a collection of independent interventions. Universities should periodically assess students' attitudes, perceived behavioral control, perceived social support, and exposure to entrepreneurship education to identify potential bottlenecks. For

students with favorable attitudes but low perceived capability, practical training and mentoring should be prioritized. For students with sufficient competence but weak social support, networking and role model exposure may be more appropriate. Such differentiated interventions would enable universities to allocate entrepreneurship resources more effectively and create conditions under which students are not only interested in digital entrepreneurship but also perceive it as feasible, socially supported, and realistically attainable.

7. Limitations and Future Work

This study has several limitations. First, the cross-sectional design limits the ability to establish causal relationships and capture changes in digital entrepreneurial intention over time. Future studies should employ longitudinal or experimental designs to examine how entrepreneurship education influences students' intentions across different stages of learning. Second, the sample was restricted to university students in Ho Chi Minh City, which may limit the generalizability of the findings to other regions, educational settings, or non-student populations. Future research should therefore examine more diverse samples and conduct cross-regional or cross-country comparisons. Third, the study focused on digital entrepreneurial intention rather than actual entrepreneurial behavior. Future studies could extend the model by incorporating digital entrepreneurial behavior to examine the intention-behavior transition. Finally, additional psychological, technological, and contextual conditions may be incorporated to further explain the mechanisms of sufficiency and necessity underlying digital entrepreneurship.

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