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Strategic Thinking and Digital Entrepreneurial Intention in Higher Education: A Sustainable Development Planning Perspective

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ABSTRACT

Digital entrepreneurship is increasingly recognized as a strategic pathway for advancing sustainable economic development, inclusive innovation, and development planning in emerging economies. In higher education, students are expected not only to adopt digital technologies but also to transform digital opportunities into sustainable entrepreneurial initiatives. However, the cognitive and attitudinal processes through which university students develop intentions to engage in sustainable digital entrepreneurship remain insufficiently understood. Drawing on the Theory of Planned Behavior (TPB), this study examines how strategic thinking shapes digital entrepreneurial intention (DEI) by positioning synthetic (SyT), creative (CreT), and visionary thinking (ViT) as pre-attitudinal cognitive mechanisms within a sustainable development planning perspective. Using survey data from 1,056 engineering students across three Indonesian universities, this study applies Partial Least Squares Structural Equation Modeling (PLS-SEM) to test the relationships among smartphone use (SU), locus of control (LoC), strategic thinking, digital entrepreneurial attitudes (DEA), and DEI. The findings show that SU and LoC significantly enhance all dimensions of strategic thinking. Strategic thinking, in turn, positively influences digital entrepreneurial attitudes, while digital entrepreneurial attitudes emerge as the strongest predictor of intention. The direct effects of strategic thinking on intention are not significant, indicating that cognitive capabilities contribute to entrepreneurial intention primarily through evaluative mechanisms rather than direct motivational pathways. From a sustainable development planning perspective, these findings suggest that universities should not only develop students' digital and strategic capabilities but also design learning environments that transform such capabilities into positive entrepreneurial attitudes aligned with sustainability, innovation, and inclusive economic development. This study contributes to digital entrepreneurship, higher education, and sustainable development planning literature by demonstrating that strategic thinking functions as a cognitive foundation for sustainability-oriented digital entrepreneurial readiness.

1. INTRODUCTION

Digital technologies are transforming not only how businesses are created but also how universities design learning environments that prepare students for innovation-driven economies [1]. In higher education, digital entrepreneurship has emerged as a key educational objective, particularly in fostering creativity, adaptability, and sustainable economic participation among students [2]. The ability to think creatively, identify opportunities, and transform digital tools into profitable business concepts, as well as the technology infrastructure, are essential for digital entrepreneurship [3]. Students in higher education are increasingly viewed as essential contributors to this change, particularly in developing countries where digital platforms mitigate barriers to entrepreneurship [4].

Recent study indicates that university students' intentions regarding digital entrepreneurship are inconsistent, despite their extensive access to digital technologies [5]. This contradiction implies that the mere availability of technology is insufficient to foster entrepreneurial purpose [6]. The creation of intentions is shaped by complex psychological, cognitive, and attitudinal processes [7]. In countries that are still in the process of development, such as Indonesia, where cellphones are the primary means of communication, learning, and conducting business, it is particularly crucial to comprehend these stages [8].

From a sustainable development planning perspective, this challenge is significant because the development of digital entrepreneurship must be aligned with broader goals of inclusive growth, innovation capacity, social empowerment, and long-term economic sustainability [9]. Digital ventures created by young entrepreneurs can contribute to employment creation, local innovation ecosystems, regional development, and digital inclusion [1]. Nevertheless, such contributions depend on whether students are able to evaluate digital opportunities not merely as short-term business possibilities, but as sustainable value-creating activities [10]. Consequently, entrepreneurship education should encourage students to integrate digital capabilities with strategic thinking, sustainability awareness, and development-oriented decision-making.

The Theory of Planned Behavior (TPB), is a theory to clarify entrepreneurial intention, positing that intention is predicted by attitudes towards the behavior, subjective norms, and perceived behavioral control [11]. In the realm of entrepreneurship research, TPB has proven to be a reliable and concise framework, particularly within student populations [12]. The TPB effectively illustrates the aspirations of individuals to participate in entrepreneurial activities; however, it offers a limited comprehension of the cognitive processes that influence entrepreneurial attitudes and intentions, particularly in the context of digital entrepreneurship, which is marked by significant uncertainty and rapid technological advancements [13, 14].

The TPB argues that intention is shaped by attitudes toward behavior, subjective norms, and perceived behavioral control [15]. While this framework provides a strong foundation for understanding intention formation, it offers limited explanation of the cognitive processes through which students interpret digital opportunities, synthesize information, imagine future business possibilities, and evaluate whether digital entrepreneurship is desirable and feasible [16]. This limitation becomes particularly important in digital entrepreneurship, where uncertainty, rapid technological change, and evolving digital business models require students to continuously interpret new opportunities.

When initiating a digital enterprise, it is essential to strategize and contemplate. Individuals must enhance their understanding of the business, generate innovative concepts, and anticipate future developments to ascertain feasibility [1]. Strategic thinking, a sophisticated cognitive ability enabling individuals to synthesize information, engage in creative thought, and anticipate future outcomes, encompasses the processes [17, 18]. A growing body of research indicates that strategic thinking is a multifaceted concept encompassing synthetic, creative, and visionary thinking processes [17, 19]. These attributes reveal how people plan for the future and how they think about and solve tough situations.

Notwithstanding its significance, strategic thinking is still inadequately examined within intention-based entrepreneurial frameworks [20, 21]. Contemporary research often focuses on isolated cognitive traits or perceives thinking as a unidimensional construct, so overlooking the distinctive roles of synthetic (SyT), creative (CreT), and visionary thinking (ViT) in shaping entrepreneurial evaluations [17]. Additionally, there is limited research that explicitly incorporates strategic thinking within the TPB paradigm to elucidate the cognitive development of entrepreneurial attitudes and intents.

Simultaneously, digital entrepreneurship is fundamentally anchored in quotidian digital activities [1]. Most college students in Indonesia use mobile phones to gather information, connect with digital platforms, and look for business prospects [22]. Previous research predominantly indicates that smartphone use (SU) might serve as a distraction or result in overconsumption. On the other hand, other people argue that phones are cognitive-enhancing tools that help people learn how to think strategically [23]. People would be able to think about things in more creative, synthetic, and visionary ways if they use their phones all the time to read digital content, chat about markets, and discuss new ideas [24].

Strategic thinking is essential in influencing digital entrepreneurial attitudes (DEA), which reflect individuals' assessments of the desirability and feasibility of participating in digital entrepreneurship [25, 26]. Students capable of integrating diverse information, engaging in creative thought, and envisioning the future are more inclined to perceive digital business as attractive and feasible [27, 28]. The fundamental tenets of the TPB suggest that these favorable assessments should increase the number of individuals aspiring to become digital entrepreneurs [5].

Considering this, the study formulates and evaluates a comprehensive model of Indonesian college students' intentions to become digital entrepreneurs. This study delineates the cognitive and emotional formation of digital entrepreneurs' intentions by examining SU and the locus of control (LoC) as antecedents to strategic thinking aspects, thereby integrating strategic thinking into the TPB framework. This research enhances TPB by incorporating strategic thinking as a cognitive approach. It also delivers real-world statistics from a developing economy where more and more people see digital business as a method to help the economy thrive in a fair and long-lasting way.

This study responds to these gaps by proposing an attitude-focused extension of the TPB that positions strategic thinking as a cognitive precursor to DEA and digital entrepreneurial intention (DEI). Specifically, the study examines how SU and LoC influence SyT, CreT, and ViT, and how these dimensions shape DEA and DEI among Indonesian engineering students. Engineering students represent a relevant group because they are frequently exposed to technology-intensive learning environments, design thinking, feasibility analysis, and innovation-oriented problem solving.

The contribution of this study is threefold. First, it advances digital entrepreneurship research by conceptualizing strategic thinking as a pre-attitudinal cognitive mechanism that explains how students form evaluative judgments toward digital entrepreneurship. Second, it extends the TPB by explaining how strategic thinking functions as a pre-attitudinal cognitive mechanism that shapes DEA. Third, it offers practical implications for higher education and development policy by emphasizing the need for curricula that integrate digital competencies, strategic thinking, sustainability-oriented

entrepreneurship, and experiential learning. In doing so, this study positions higher education as a key institutional actor in planning and developing sustainable digital entrepreneurship ecosystems in emerging economies.

In this study, sustainable development planning is used as a contextual lens rather than as a directly measured construct. The empirical model focuses on individual-level cognitive and attitudinal mechanisms that may support the preparation of future digital entrepreneurs within broader sustainable development agendas.

2. LITERATURE REVIEW

2.1 Theory of Planned Behavior

The TPB has emerged as a prominent theoretical paradigm for elucidating entrepreneurial purpose, especially in higher education settings [12]. According to the TPB, purpose precedes behavior and is influenced by the emotions people experience, perception of the norms, and perception of the level of control over the behavior [29]. TPB is prominent in entrepreneurship research due to its capacity to elucidate various phenomena and its applicability across diverse cultural and institutional contexts [14]. This study does not alter the fundamental framework of the TPB for this reason. Rather, it proposes a process-oriented enhancement, positioning strategic thinking as a cognitive predecessor to attitude, which is more distant in the TPB.

The TPB has been extensively employed, however, it is increasingly receiving criticism for its inability to elucidate the manner in which individuals consider and make decisions, particularly in scenarios characterized by rapid change and significant uncertainty, such as digital entrepreneurship [14, 24]. Although the TPB effectively addresses the evaluative and regulatory factors influencing intention, it lacks sufficient detail regarding the cognitive process's individuals employ to comprehend information, envision potential business trajectories, or assess data [30]. This constraint is particularly acute for digital entrepreneurs, who are required to consistently acquire new knowledge, integrate a variety of data types, and make autonomous decisions [31].

The TPB has not undergone significant modifications in terms of its operational principles. It bolsters the TPB by emphasizing the process, which posits that attitude formation occurs subsequent to strategic thinking, a cognitive process that occurs at a distance [11].

In order for the TPB to be effective, it is necessary to consider an individual's attitude, subjective standards, and sense of behavioral control. This fundamental framework has not been altered in any respect in the new model. Numerous individuals believe that the capacity to think strategically is an inherent talent that alters their perception of online businesses. One approach to examining the model is to adopt a process-based perspective on TPB. This theory posits that strategic thinking is the process of connecting judging thoughts (attitudes) to plans. As a result, the TPB does not incorporate a significant amount of strategic thinking. Rather, it is a critical component of the Theory's framework and a mode of thought that precedes attitudes.

2.1.1 Conceptual rationale for the proposed model

This study does not aim to supplant the traditional framework of the TPB. Instead, it concentrates on a particular explanatory pathway within the TPB, specifically the development of attitudes toward digital entrepreneurship. In the traditional TPB, attitude, subjective norms, and perceived behavioral control are regarded as immediate predictors of intention [32]. Nonetheless, TPB offers scant elucidation on the cognitive formation of such attitudes, especially within digitally mediated and uncertain entrepreneurial environments.

This study identifies strategic thinking as a remote cognitive precursor of attitude, as it demonstrates individuals' ability to synthesize information, create innovative options, and foresee future prospects prior to forming evaluative assessments [17]. From this viewpoint, strategic thinking does not directly replace the original TPB predictors, instead, it elucidates a preliminary cognitive process by which individuals recognize digital entrepreneurship as both desirable and feasible.

The current framework does not dismiss subjective norms and perceived behavioral control. Rather, they are regarded as significant components of the TPB that lie beyond the focal mechanism analyzed in this study. However, this study does not test the full TPB model. Instead, it focuses on the attitudinal pathway of TPB by examining how strategic thinking operates as a pre-attitudinal cognitive mechanism that shapes DEA, which subsequently influences DEI.

This study adopts an attitude-focused extension of the TPB. Rather than testing the complete TPB framework, the study concentrates on the attitudinal pathway through which DEI is formed. In this model, strategic thinking is positioned as a pre-attitudinal cognitive mechanism that helps students synthesize digital information, generate creative opportunities, and envision future entrepreneurial possibilities. These cognitive processes are expected to shape students' evaluations of digital entrepreneurship, which subsequently influence their entrepreneurial intention. Therefore, strategic thinking does not replace the original TPB components but explains how DEA may be cognitively formed in technology-intensive higher education contexts.

2.2 Strategic thinking

Strategic thinking denotes an advanced cognitive skill that allows individuals to analyze intricate settings, synthesize varied knowledge, devise creative solutions, and foresee long-term strategies [17]. In entrepreneurship, strategic thinking is essential for identifying opportunities, coordinating resources, and managing uncertainty these are skills that are especially important in digital environments marked by swift change and ambiguity [33].

Strategic thinking as a multidimensional construct rather than a singular, uniform entity [17]. This study characterizes strategic thinking as comprising synthetic, creative, and visionary cognition which collectively represent the cognitive processes fundamental to entrepreneurial sensemaking and decision-making. These aspects are regarded as complementary rather than interchangeable, illustrating distinct yet interconnected styles of strategic cognition essential for digital entrepreneurship [34].

Although CreT, ViT, and DEA may appear conceptually proximal, they represent distinct theoretical domains. Strategic thinking dimensions capture cognitive processing styles (how individuals generate, integrate, and project ideas), whereas DEA reflects evaluative judgment regarding the desirability and feasibility of entrepreneurship.

CreT and ViT describe cognitive capability, while attitude reflects affective, evaluative orientation. Thus, cognitive

readiness should not be equated with motivational evaluation.

2.2.1 Synthetic thinking

The capacity of individuals to incorporate divergent, diverse, and frequently ambiguous knowledge into coherent conceptual frameworks is referred to as SyT [17]. In digital entrepreneurship, it is common for individuals to combine personal resources, market signals, and technological competencies to conduct a comprehensive assessment of potential viability [1, 35]. SyT empowers individuals to identify patterns, address complexity, and assess the feasibility of integrating various components into functional digital business concepts [36].

SyT, a component of strategic thinking, is especially relevant for assessing feasibility and alignment in entrepreneurial decision-making [17]. Digital entrepreneurial opportunities are more likely to be systematically evaluated and entrepreneurship is perceived as viable and achievable by individuals with strong SyT abilities [37]. Thus, SyT is likely to have an effect on both DEA and intents.

2.2.2 Creative thinking

CreT is the capacity to generate innovative, original, and valuable concepts [17, 38]. The study of entrepreneurship posits that creativity is a fundamental talent for the generation of opportunity and innovation [39]. In digital entrepreneurship, innovative thinking is essential, as digital platforms often encourage experimentation, distinction, and originality [40].

CreT, as a component of strategic thinking, enables individuals to explore alternative concepts, challenge prevalent assumptions, and develop innovative digital value propositions [41]. Creative thinkers are more inclined to view digital entrepreneurship as personally meaningful and consistent with self-expression, which in turn enhances their favorable entrepreneurial evaluations [42]. Furthermore, CreT can directly increase entrepreneurial intention by bolstering confidence in one's ability to develop viable business concepts within digital contexts [43].

2.2.3 Visionary thinking

ViT encompasses individuals' future-oriented cognitive orientation and the ability to foresee long-term events, developing trends, and potential possibilities [17]. In contrast to short-term problem solving, ViT entails seeing alternate futures and mentally simulating entrepreneurial pathways across time [34, 44]. In digital entrepreneurship, where technological and commercial environments change swiftly, ViT is essential for anticipating opportunities and exercising strategic foresight [45].

ViT, as an aspect of strategic thinking, influences individuals' perceptions of the long-term worth and significance of digital entrepreneurship [46]. ViT as a crucial cognitive catalyst that connects current decision-making with future entrepreneurial endeavors [47].

2.3 Digital entrepreneurial intention

Intention is theoretically grounded in the TPB, wherein attitudes toward digital entrepreneurship, self-control, societal norms, and personal beliefs converge to shape the intention to do entrepreneurial activities [48]. DEI denotes a person's propensity or purpose to participate in digital entrepreneurship, typically assessed by a psychometric scale that indicates aspirations, motivations, and preparedness to operate in the digital domain. DEI is the desire to run a business like an entrepreneur [49]. This concept illustrates why people start and grow digital businesses. DEI found factors that encourage or discourage field entry [50]. Digital entrepreneurs can grow innovatively and sustainably with strategies, initiatives, and methods [3, 51]. Such achievement is facilitated by thoroughly comprehending intention [52]. Strategic thinking significantly impacts entrepreneurs by enabling them to create inventive and efficient business strategies [53]. A strategic viewpoint is crucial for digital entrepreneurs as it allows them to take advantage of emerging opportunities and manage the ever-changing digital landscape.

2.4 Digital entrepreneurial attitude

DEA refers to students' positive or negative evaluation of engaging in digital entrepreneurship. It reflects the extent to which students perceive digital entrepreneurship as desirable, feasible, meaningful, and relevant to their future career [54]. Furthermore, having a business mindset includes being creative with technology, being open to new things, being willing to change, and knowing how to do things online [55]. These attributes enable business owners to make the most of opportunities and do successfully online. If digital entrepreneurs want to be successful, they need to be willing to attempt new things and take fair risks when they put new digital solutions into action [56].

Strategic thinking plays a key role in encouraging entrepreneurial intentions, especially in digital entrepreneurship. It gives young business owners the tools they need to adjust to the trends, which helps them stay competitive. If they plan strategically, businesses can handle unpredictability, take advantage of new opportunities, and stay strong in the digital world that is continually evolving.

From a TPB perspective, DEA serves as a mediating cognitive mechanism by which intrinsic psychological traits, cognitive abilities, and digital experiences affect entrepreneurial intention [5]. DEI does not arise spontaneously, instead, it is developed through a cognitive process where individuals assess digital prospects and convert these assessments into positive or negative attitudes [25]. These attitudes serve as the direct precursor of intention. Thus, DEA serves as an essential link between upstream factors, including strategic thinking, LoC, and SU, and DEI.

2.5 Locus of control

LoC denotes individuals' overarching ideas about the degree to which outcomes depend on the actions as opposed to other factors like luck, fate, or authority [57]. Within the realm of entrepreneurship, LoC has historically been linked to initiative, perseverance, and tolerance for ambiguity [57].

In the TPB, LoC is theoretically similar to perceived behavioral control, as both reflect individuals' beliefs regarding the ability to execute a specific behavior [57]. This study conceptualizes LoC not as a direct predictor of entrepreneurial intention, but as a psychological antecedent that influences strategic cognition. Individuals who perceive outcomes as controllable are more inclined to actively digest information, experiment with concepts, and engage in prospective thinking [58]. LoC is likely to affect how strategic thinking grows when it comes to SyT, CreT, and ViT, all of which are important for getting around in the digital business world.

LoC denotes a more generalized belief concerning control over life outcomes [57]. This study positions LoC as an upstream psychological resource that facilitates strategic cognition, rather than as a direct replacement for perceived behavioral control.

2.6 Smartphones use

The use of smartphones is a metric for the manner in which individuals interact with digital technologies while on the move, including the creation of content, communication with others, information retrieval, and participation in online communities [59]. SU is the primary method by which Indonesian college students access a variety of online ecosystems, including social media, learning platforms, and emerging digital marketplaces [60]. Therefore, cellphones are not merely a communication tool; they are essential instruments that are an essential component of our daily mental and behavioral routines.

In contrast to the majority of the existing literature, which portrays SU as problematic, distracting, or indicative of digital dependency, an alternative and more pertinent perspective views cellphones as tools that enhance cognitive abilities [61]. The constant stream of diverse information, digital content, and business stories that individuals encounter on their phones can influence their ways of thinking, learning, and perceiving possibilities [62]. The utilization of smartphones accelerates the acquisition of new knowledge, encourages the utilization of digital tools for the purpose of discovery, and enables the prediction of emerging trends [63].

This research conceptualizes SU as exposure to digitally mediated contexts, rather than as mere device dependence. The sustained use of digital platforms may lead to an increase in the availability of entrepreneurial stories, market signals, and innovation-related data, which has the potential to promote the development of thought processes that are beneficial for strategic planning.

Nonetheless, it is recognized that frequency-based assessment may not accurately reflect entrepreneurial learning-oriented utilization. The present operationalization predominantly indicates the intensity of participation rather than task-specific entrepreneurial conduct. This distinction is significant and is a constraint of the study.

2.7 Hypothesis development

People with an external LoC tend to believe that events in life are determined by chance or outside forces. Understanding one's LoC can help individuals recognize how they react to situations, overcome challenges, and achieve the goals [64]. Those with an internal LoC, on the other hand, tend to think more synthetically. For example, pre-service teachers with an internal LoC engage in more synthetic practices [65]. Additionally, individuals with an internal LoC are more likely to take responsibility for the actions and the outcomes, making it easier for them to reflect on and change the behaviors [64]. Consequently, the subsequent hypothesis appears plausible:
H1: *LoC positively influences SyT.*
H2: *LoC positively influences CreT.*
H3: *LoC positively influences ViT.*

The relation between using smartphones and thinking deeply is complicated and can have both good and bad effects, depending on how people use their phones [66]. How people handle their SU, the material they look at, and how they interact with the devices all affect how much they reflect [67]. Smartphones can give you access to useful content and apps that can help you learn and reflect on your own when you know how to use them [68]. However, it is also important to set limits so that you don't get too busy or lose focus. Changing how you look at things can also help you understand, evaluate, and solve problems [69]. Furthermore, smartphones have access to articles, online courses, and educational materials in ViT. This could improve the comprehension and practical application of ViT [70]. Consequently, the subsequent hypothesis appears plausible:
H4: *SU positively influences SyT.*
H5: *SU positively influences CreT.*
H6: *SU positively influences ViT.*

For digital entrepreneurs to succeed, understanding the technology, operations, marketing, and customer service roles is essential [71, 72]. ViT can help students improve the decision-making by predicting how changes in one area affect others. Research shows that entrepreneurs who use ViT are better at handling complex situations [73]. This approach allows digital entrepreneurs to innovate, plan, and adapt to the digital world [74]. Additionally, ViT helps individuals make better decisions by predicting the consequences of changes in any part of the business [75]. Consequently, the subsequent hypothesis appears plausible:
H7: *ViT positively influences DEA.*
H8: *ViT positively influences DEI.*

Changing one's viewpoint is a key part of CreT, which helps people approach opportunities and challenges in a new way [76, 77]. CreT improves adaptability by allowing people to adjust the strategies based on new information or changing circumstances [75]. People can see things from different points of view and see new opportunities or challenges by shifting their thoughts [78]. Entrepreneurs who can change the way they think are more likely to find digital innovations and use them [71, 76]. Consequently, the subsequent hypothesis appears plausible:
H9: *CreT positively influences DEA.*
H10: *CreT positively influences DEI.*

Entrepreneurs who are very good at creative are much more likely to see digital opportunities and take advantage of them [71]. Being better able to spot and seize new business opportunities may make people more motivated to become digital entrepreneurs [3]. Creative one's thinking improves opportunity recognition, problem-solving, risk management, and flexibility. Synthetic thinking includes reflection on strengths, weaknesses, and previous experiences [79]. When entrepreneurs set goals, they need to be honest with themselves about what they can and can't do. Self-awareness helps them figure out what drives and motivates them [80]. Consequently, the subsequent hypothesis appears plausible:
H11: *SyT positively influences DEA.*
H12: *SyT positively influences DEI.*

SyT involves a thorough analysis of one's actions, decisions, and experiences to gain insight from mistakes and enhance future performance; it is crucial to possess profound self-control to set realistic and suitable goals that align with your specific circumstances [51, 79]. Entrepreneurs can discern the motivations and driving forces through LoC [64].

Entrepreneurs can enhance the commitment to entrepreneurship by aligning the goals with the skills and expertise. Moreover, a person with an exemplary LoC often exhibits a higher level of initiative and self-confidence, leading to a greater inclination toward entrepreneurship [5]. Entrepreneurs can navigate uncertainty, devise effective plans, and adapt the strategies in the digital realm through strategic thinking [74, 81]. Strategic thinking influences the relationship between SU and DEI [5]. Strategic thinking helps people develop and implement digital business strategies using smartphone apps by turning smartphone insights into effective entrepreneurial strategies [82]. Smartphones enable strategic information and resource use, fostering entrepreneurial plans and intentions. However, without strategic thinking, smartphones may fail to establish an entrepreneurial intention [5, 83]. Strategic thinking is crucial for transforming the advantages of smartphones into entrepreneurial objectives. Consequently, the subsequent hypothesis appears plausible:

H13: *DEA positively influences DEI.*

The conceptual model of this study is shown in Figure 1. The framework explains how locus of control and smartphone use contribute to digital entrepreneurship intention through synthetic thinking, creative thinking, visionary thinking, and digital entrepreneurial attitudes.

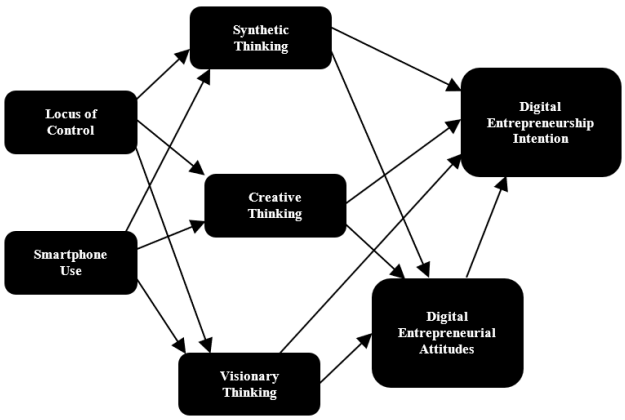

Figure 1. Hypothesis development

3. METHODOLOGY

3.1 Data and measurement

Participants were engineering students enrolled in Indonesian higher education institutions (HEI). A convenience sampling approach was used due to access constraints and the large student population. Therefore, the findings should be interpreted as reflecting engineering student in Indonesia respondents rather than the broader population of higher education students in Indonesia. Students enrolled in engineering degree programs at the university level are the subjects of this quantitative study. In order to see the interrelationships between the variables in great depth, the quantitative approach is useful. To make the process easier but less rigorous, participants were selected using convenience sampling, which was necessary due to the vast number of students [84].

The study included 1,056 engineering students in Indonesian HEI. These participants were recruited online and completed a web-based questionnaire that contained questions related to the study's variables.

Participants were recruited from engineering faculties of several Indonesian HEI located in different regions. The respondents were primarily students enrolled in public universities with strong technological and engineering programs, Padang State University in West Sumatra Province, Malang State University in East Java Province, Indonesia University of Education in West Java Province. Due to logistical constraints and the large population of university students in Indonesia, a convenience sampling approach was adopted. Therefore, the findings should be interpreted as representing engineering students participating in this survey rather than the entire population of higher education students in Indonesia. Future research should incorporate cross-regional data collection and probability-based sampling methods to enhance representativeness.

The emphasis on engineering students was theoretically justified. Engineering students are more inclined than their peers in various disciplines to engage in technology-intensive learning environments that prioritize design, experimentation, feasibility analysis, and innovation-driven problem solving. These features are conceptually congruent with the dimensions of strategic thinking analyzed in this study and with the rationale of digital entrepreneurship, which frequently entails converting technical knowledge and digital resources into feasible opportunity frameworks [4, 60]. Consequently, engineering students constitute a pertinent demographic for evaluating the proposed model.

The majority of respondents were engineering students, as they typically excel in digital technology, technical innovation, and problem-solving compared to students from other disciplines. In engineering programs, students frequently utilize digital resources and engage in project-based learning. This instructs students on strategic planning, essential for individuals aspiring to establish their own digital enterprises. Furthermore, engineering education encompasses courses on entrepreneurship. This group can assist us in elucidating the relationship between strategic thinking and the aspiration to be an entrepreneur in the digital realm.

Table 1. Respondents demographic

Age (in Year)		
> 24	70	6.63%
23–24	105	9.94%
21–22	417	39.49%
19–20	435	41.19%
17–18	29	2.75%
Total	1056	100.00%
Gender		
Woman	436	41.29%
Man	620	58.71%
Total	1056	100.00%
Average Internet Usage a Day (in Hour)		
> 10	341	32.29%
7–9	329	31.16%
4–6	347	32.86%
1–3	39	3.69%
Total	1056	100.00%

Table 1 presents the demographics of the participants. In terms of age, the majority were between 19 and 22 years old (80.68%), with smaller groups in the 23–24 age range (9.94%) and those over 24 (6.63%). A small percentage were aged 17–18 (2.75%). Regarding gender, 58.71% of participants were

male and 41.29% were female.

In terms of internet usage, the study found that 341 respondents (32.29%) used the internet for more than 10 hours a day, 329 (31.16%) used it for 7–9 hours, 347 (32.86%) used it for 4–6 hours, and 39 (3.69%) used it for 1–3 hours. This data helps to understand how often students use the internet, which may influence how they interact with digital tools in their education.

3.2 Measurement instrument

All constructs were measured using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The primary data collection tool in this experiment was questionnaires. This study used previous primary research assessment tools. Research variables are assessed by questionnaire. This questionnaire collects data on SU, LoC, strategic thinking framework (SyT, CreT, and ViT), and digital entrepreneurship goals and attitudes.

This study used an instrument to measure the LoC from a previous study [85], the LoC instrument is four items that represent respondents' feelings on this variable. The use of smartphone engagement was operationalized using frequency-based items adapted from prior studies. While this captures digital exposure intensity, it does not differentiate between passive consumption and entrepreneurial learning-oriented activities. This study uses an instrument to measure SU [61], four items can represent the feelings felt by respondents about their habits towards SU. The smartphone construct was implemented through frequency-based items derived from previous research. Although these items effectively capture the intensity of smartphone engagement, they fail to distinguish whether SU is directed towards entrepreneurial learning, business experimentation, information retrieval, social interaction, or passive entertainment consumption. Consequently, the operationalization may inadequately reflect the theoretically intended construct of entrepreneurial digital exposure, necessitating that the findings be interpreted with this measurement limitation considered.

This study measures SyT using a previous research instrument, three items were used to represent respondents' feelings about SyT [17]. This study measures CreT using a previous research instrument, study demonstrates respondents' feelings about this variable with three items [17]. For ViT, this study uses a previous instrument in this study, three items can represent respondents' feelings about this variable [17].

In the DEA variable, this study adopts instruments from previous research [86], five items can represent respondents' feelings about this variable. This study uses previous research instruments to measure digital entrepreneurship present six items representing respondents' feelings about this variable in this study [87].

3.3 Data analysis

The data was examined utilizing SmartPLS version 4. SmartPLS is used to assess data quality and construct models. The data for this inquiry was analyzed using a two-step process. The first stage consisted of determining the accuracy and consistency of the measuring model [88]. The researchers used AVE and item loading to test the study's convergent validity.

A number of steps were taken to make sure that common method bias was kept to a minimum. First, respondents were guaranteed that their responses would be kept confidential and anonymous in order to mitigate social desirability bias. Second, measurement items were taken from instruments that had already been tested and found to be reliable and clear. Third, the predictor and criterion variables were put in different parts of the questionnaire so that people wouldn't be tempted to give the same answers for both types of questions.

Also, statistical tests were done using values for the variance inflation factor (VIF). All of the VIF values were less than the safe level of 3.3, which means that common method bias and multicollinearity are not likely to make the results invalid.

This study employed both procedural and statistical remedies to evaluate the potential for common method bias. Anonymity and confidentiality were prioritized, previously validated scales were utilized, and predictor and criterion constructs were delineated across distinct sections of the questionnaire. The evaluation of full collinearity was conducted using VIF values. All construct-level and indicator-level VIF values were below the conservative threshold of 3.3, indicating that common method bias was unlikely to be significant in the current dataset. However, since all variables were obtained through self-reported responses from the same participants at a singular moment, common method variance cannot be completely dismissed. The results should consequently be interpreted with suitable methodological prudence.

4. RESULTS AND DISCUSSION

4.1 Measurement model

Partial Least Squares Structural Equation Modeling (PLS-SEM) was implemented due to the study's prediction-oriented nature, which sought to optimize the variance explained in DEI and to identify priority levers through Importance-Performance Map Analysis (IPMA). PLS-SEM is a good way to estimate complex models without making too many assumptions about how they are distributed because the suggested model has many latent components and mediation pathways. As a result, PLS-SEM is a good way to look at both the accuracy of measurements and the accuracy of predictions in this research setting. VIF values at the indicator level were used to test for collinearity. Every VIF value in Table 2 was between 1.266 and 3.260. These values fall below the conservative threshold of 3.3 recommended for PLS-SEM to detect potential common method bias and multicollinearity issues, and well below the more liberal threshold of 5.0 suggested by Hair et al. [89]. The highest VIF values were observed for DEI2 (3.260), DEI4 (3.250), DEI3 (3.233), and DEI6 (3.160). While these values are relatively higher compared to other indicators, they remain within acceptable limits and do not indicate problematic multicollinearity.

Overall, the collinearity assessment confirms that the measurement model does not suffer from substantial multicollinearity, and the distinctiveness among constructs is maintained.

We used the coefficient of determination (R^2) and adjusted R^2 values to test how well the structural model explained things. In Table 3, the R^2 values for the endogenous constructs are shown. These values range from 0.201 to 0.653. DEI has the best ability to explain variation in intention ($R^2 = 0.653$; adjusted $R^2 = 0.652$), which means that its predictors can

explain about 65.3% of the variation in intention. Following the established rules [89], this value can be seen as significant, showing that the suggested TPB-augmented model is very good at making predictions.

DEA have a lower but still significant level of explanatory power ($R^2 = 0.201$; adjusted $R^2 = 0.199$), which suggests that strategic thinking dimensions explain about 20% of the variation in attitudes. Even though this level is moderate to weak, it shows that mental or environmental factors may play a role in shaping attitudes in addition to cognitive processes.

Table 2. Variance inflation factor (VIF)

Item	VIF
CreT1	1.550
CreT2	1.931
CreT3	1.779
DEA1	2.711
DEA2	2.907
DEA3	2.258
DEA4	2.889
DEA5	2.902
DEI1	2.231
DEI2	3.260
DEI3	3.233
DEI4	3.250
DEI5	2.699
DEI6	3.160
LoC1	1.709
LoC2	1.952
LoC3	1.389
LoC4	1.327
SU1	1.409
SU2	1.273
SU3	1.266
SU4	1.495
SyT1	2.190
SyT2	2.177
SyT3	1.542
ViT1	1.884
ViT2	2.071
ViT3	1.789

Table 3. Coefficient of determination

Variable	R^2	R^2 Adjusted
CreT	0.308	0.306
DEA	0.201	0.199
DEI	0.653	0.652
SyT	0.335	0.334
ViT	0.356	0.355

Note: DEA = digital entrepreneurial attitudes; DEI = digital entrepreneurial intention; ViT = visionary thinking; CreT= creative thinking; LoC = locus of control; SU = smartphone use; SyT = synthetic thinking.

The model explains 30.8% of the variation in CreT ($R^2 = 0.308$), 33.5% of the variation in SyT ($R^2 = 0.335$), and 35.6% of the variation in ViT ($R^2 = 0.356$). The moderate explanatory power of these values suggests that the LoC and SU have a meaningful effect on the development of strategic thinking. The small differences between R^2 and adjusted R^2 values across constructs show that the model is stable and not overfitting.

To figure out how much each exogenous factor affected the endogenous factors shown in Table 4, effect sizes (f^2) were used. DEA have a big impact on DEI ($f^2 = 1.391$), which supports its important role in the TPB-based framework.

Table 4. Effect sizes (f^2)

Variable	CreT	DEA	DEI	LoC	SU	SyT	ViT
CreT		0.016	0.000				
DEA			1.391				
DEI							
LoC	0.085					0.165	0.139
SU	0.202					0.152	0.211
SyT		0.030	0.003				
ViT		0.005	0.001				

Note: DEA = digital entrepreneurial attitudes; DEI = digital entrepreneurial intention; ViT = visionary thinking; CreT= creative thinking; LoC = locus of control; SU = smartphone use; SyT = synthetic thinking.

On the other hand, CreT, SyT, and ViT have very small direct effects on intention (f^2 values between 0.000 and 0.003). This supports the idea that attitude acts as a mediator. When it comes to factors that lead to strategic thinking, using a smartphone has medium effects on CreT ($f^2 = 0.202$), SyT ($f^2 = 0.152$), and ViT ($f^2 = 0.211$), which suggests that it provides useful mental stimulation. There are small to medium effects of LoC, with SyT being the most affected ($f^2 = 0.165$). These findings show that even though behavioral and cognitive factors have a big impact on strategic thinking, intention formation is still mostly determined by how people feel about something rather than how their brain works directly.

The predictive value of the structural model was tested using Stone–Geisser's Q^2 value, which was found by blindfolding the procedures shown in Table 5. All endogenous constructs have Q^2 values greater than zero, which means the model can be used to make predictions. DEI has a Q^2 value of 0.474, which is higher than the minimum value needed for large predictive relevance. This means that it can strongly predict outcomes that are not in the sample.

Table 5. Construct cross-validated redundancy

Variable	SSO	SSE	Q^2
CreT	3,168.000	2483.362	0.216
DEA	5,280.000	4513.053	0.145
DEI	6,336.000	3332.641	0.474
LoC	4,224.000	4224.000	0.000
SU	4,224.000	4224.000	0.000
SyT	3,168.000	2398.349	0.243
ViT	3,168.000	2336.349	0.263

Note: DEA = digital entrepreneurial attitudes; DEI = digital entrepreneurial intention; ViT = visionary thinking; CreT= creative thinking; LoC = locus of control; SU = smartphone use; SyT = synthetic thinking.

The dimensions of strategic thinking also exhibit moderate predictive relevance, with Q^2 values of 0.216 (CreT), 0.243 (SyT), and 0.263 (ViT). DEA demonstrate a Q^2 value of 0.145, indicating small-to-moderate predictive relevance. As expected, exogenous constructs (LoC and Smartphone Engagement) show Q^2 values of 0.000, as predictive relevance is not calculated for independent variables.

Researchers tested its discriminant validity using the heterotrait-monotrait correlation ratio (HTMT) presented in Table 6.

The investigation utilized the conventional factor estimate method through PLS-SEM. This method is especially good for research with small sample numbers or data that don't strictly meet normality assumptions [89]. Numerous assessments have been conducted to evaluate the validity and reliability of the measurement model. These encompass Cronbach's alpha, composite reliability (CR), standardized indicator loadings, average variance extracted (AVE), and the HTMT.

Table 6. Heterotrait-monotrait ratio (HTMT) of correlations

Variable	CreT	DEA	DEI	LoC	SU	SyT	ViT
CreT							
DEA	0.466						
DEI	0.416	0.830					
LoC	0.521	0.348	0.383				
SU	0.632	0.329	0.262	0.476			
SyT	0.861	0.481	0.447	0.608	0.596		
ViT	0.823	0.420	0.389	0.587	0.645	0.812	

Note: DEA = digital entrepreneurial attitudes; DEI = digital entrepreneurial intention; ViT = visionary thinking; CreT= creative thinking; LoC = locus of control; SU = smartphone use; SyT = synthetic thinking.

As reported in Table 7, the CR and Cronbach's alpha values all exceed the recommended threshold of 0.70 [89], demonstrating adequate uniformity within the group. Table 7 demonstrates evidence of convergent validity. The AVE for each construct exceeds 0.50, and all indicator loadings on their corresponding latent constructs surpass 0.60. The HTMT values remain below 0.90, indicating that the criteria for discriminant validity have been satisfied.

Table 7. Cronbach's alpha, Rho_A, composite reliability (CR), average variance extracted (AVE)

Construct	Cronbach's Alpha	rho_A	CR	AVE
CreT	0.799	0.799	0.882	0.713
DEA	0.911	0.912	0.933	0.737
DEI	0.928	0.930	0.943	0.736
LoC	0.771	0.780	0.854	0.596
SU	0.703	0.722	0.813	0.523
SyT	0.820	0.820	0.893	0.736
ViT	0.829	0.829	0.898	0.745

The criteria test conducted by Fornell-Larcker is displayed in Table 8. According to the findings, all of the constructs have square roots that are greater than the correlations between them [90]. In other words, compared to other latent variables, each construct's related indicators account for a larger share of its variance. This study's measurement model has strong evidence of discriminant validity since it meets the Fornell-Larcker criteria.

Table 8. Fornell-Larcker criterion

Variable	CreT	DEA	DEI	LoC	SU	SyT	ViT
CreT	0.845						
DEA	0.399	0.859					
DEI	0.357	0.806	0.858				
LoC	0.410	0.293	0.320	0.772			
SU	0.499	0.281	0.230	0.370	0.723		
SyT	0.698	0.418	0.389	0.484	0.474	0.858	
ViT	0.670	0.367	0.341	0.469	0.516	0.669	0.863

Note: DEA = digital entrepreneurial attitudes; DEI = digital entrepreneurial intention; ViT = visionary thinking; CreT= creative thinking; LoC = locus of control; SU = smartphone use; SyT = synthetic thinking.

4.2 Structural model

Figure 2 shows the paths of all hypotheses designed in this study. Table 9 shows the analysis test results [89]. The structural model was evaluated through partial least squares structural equation modelling (PLS-SEM) to investigate the proposed relationships among LoC, SU, dimensions of strategic thinking (SyT, CreT, and ViT), DEA, and DEI. The findings indicate sufficient explanatory capacity, with the model accounting for 65.3% of the variance in DEI ($R^2 = 0.653$) and 20.1% of the variance in DEA ($R^2 = 0.201$). Moreover, the model explains 33.5% of the variance in SyT, 30.8% in CreT, and 35.6% in ViT, demonstrating a moderate explanatory capacity for the dimensions of strategic thinking.

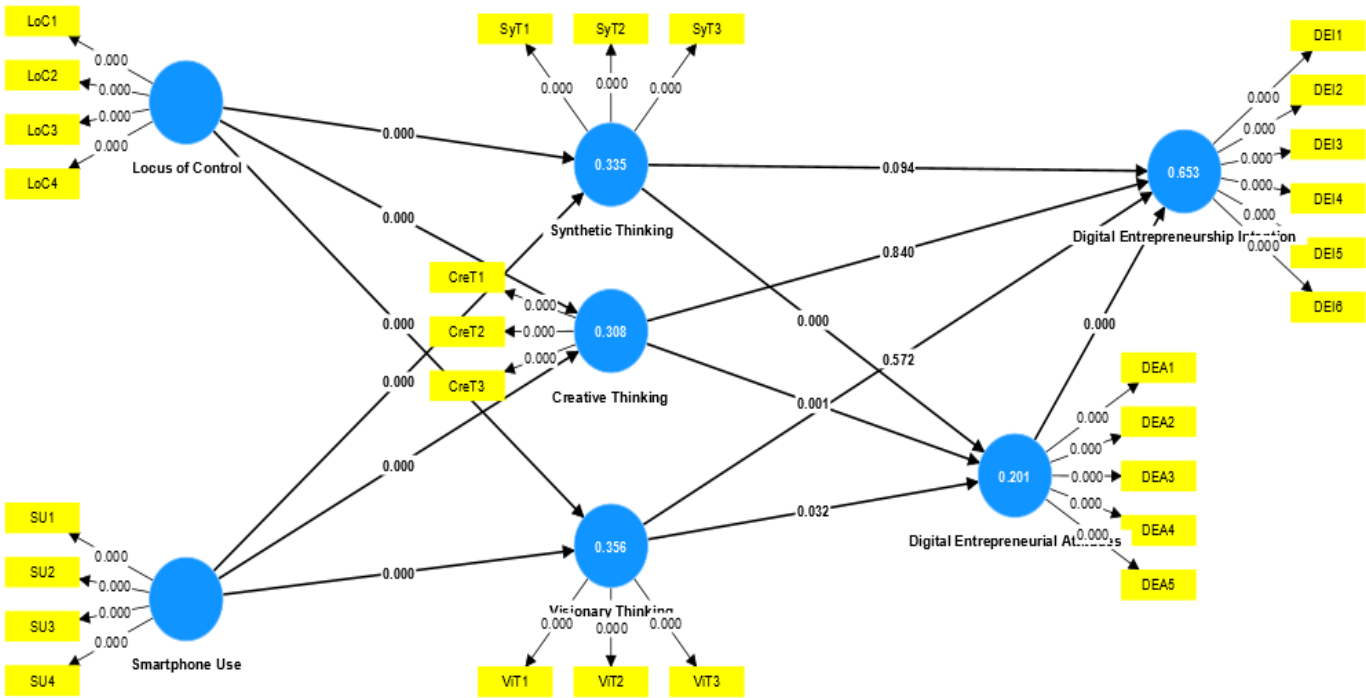

Figure 2. Hypothesis testing results

Note: DEA = digital entrepreneurial attitudes; DEI = digital entrepreneurial intention; ViT = visionary thinking; CreT= creative thinking; LoC = locus of control; SU = smartphone use; SyT = synthetic thinking.

Table 9. Summary of structural models

Hypothesis	β	t	p-Value	Results
H1	0.357	9.171	0.000	Accepted
H2	0.261	6.603	0.000	Accepted
H3	0.322	9.511	0.000	Accepted
H4	0.342	9.906	0.000	Accepted
H5	0.403	11.452	0.000	Accepted
H6	0.396	12.210	0.000	Accepted
H7	0.095	2.146	0.032	Accepted
H8	0.025	0.566	0.572	Rejected
H9	0.172	3.480	0.001	Accepted
H10	-0.007	0.202	0.840	Rejected
H11	0.235	4.513	0.000	Accepted
H12	0.052	1.677	0.094	Rejected
H13	0.777	38.149	0.000	Accepted

The impact of LoC and SU on strategic thinking: The findings demonstrate that LoC significantly influences SyT ($p = 0.000$), CreT ($p = 0.000$), and ViT ($p = 0.000$). The results corroborate H1, H2, and H3, indicating that students who perceive greater personal control over outcomes exhibit elevated levels of strategic thinking across all three dimensions. This outcome experimentally substantiates the theoretical assertion that LoC serves as a fundamental psychological resource influencing advanced cognitive capacities, rather than only functioning as a direct predictor of entrepreneurial intention [57].

Likewise, SU demonstrates substantial impacts on SyT ($p = 0.000$), CreT ($p = 0.000$), and ViT ($p = 0.000$), hence corroborating H4, H5, and H6. The data indicate that smartphone interaction significantly enhances strategic thinking growth in higher education students. The findings support the perspective that SU may expose students to diverse digital information environments that are associated with higher levels of strategic thinking [61, 91].

The findings indicate that students who are more future-oriented and capable of envisioning long-term opportunities tend to evaluate digital entrepreneurship more favorably (H7: $\beta = 0.095$, $p = 0.032$). This discovery is consistent with the literature on entrepreneurship cognition, which underscores the importance of the capacity to envision future scenarios in order to increase the strategic relevance and perceived attractiveness of opportunities [92].

Nevertheless, DEI is not significantly influenced by ViT (H8: $\beta = 0.025$, $p = 0.572$). While students may have the capacity to envision future digital possibilities, this non-significant relationship implies that such foresight is insufficient to elicit immediate entrepreneurial intention. This discovery further substantiates the notion that future-oriented cognition must initially manifest as positive evaluative judgments (attitudes) in order to inspire intentional behavior within the TPB framework. While it may not directly incite action, ViT appears to function as a distant cognitive resource by shaping perceptions of entrepreneurs [93].

The results suggest that DEA are significantly and positively influenced by CreT (H9: $\beta = 0.172$, $p = 0.001$). This discovery corresponds with previous studies suggesting that individuals skilled in producing innovative solutions and original concepts are more inclined to view entrepreneurship, particularly digital entrepreneurship, as personally meaningful and appealing. Positive attitudes are enhanced by creativity, which increases perceived self-expression, innovation, and alignment with entrepreneurial identity [39].

Contrary to expectations, CreT does not have a substantial direct impact on DEI (H10: $\beta = -0.007$, $p = 0.840$). This finding goes against the common belief that being creative and wanting to start your own business go hand in hand. Instead, it suggests that creative cognition may remain cognitively salient but motivationally insufficient if it doesn't come with positive feedback and supportive surroundings. This discovery in TPB shows how important attitudes are as the direct cause of intention. It also suggests that CreT affects intention indirectly by changing attitudes instead of directly causing action [12]. This pattern is especially useful in higher education, where students may be creative but lack the confidence, resources, or belief that their ideas can be turned into business commitments.

The results also show that among the strategic thinking dimensions, SyT has the most positive effect on attitudes toward digital entrepreneurship (H11: $\beta = 0.235$, $p = 0.000$). This finding suggests that students who are better at putting together pieces of information, figuring out if something is possible, and making sure that resources are in the right place tend to have more positive views of digital entrepreneurship. SyT is important for developing attitudes because it makes things seem more manageable and useful [94].

However, SyT does not have a direct impact on DEI (H12: $\beta = 0.052$, $p = 0.094$). This finding suggests that entrepreneurial intention is not automatically stimulated by even robust feasibility-oriented cognition unless it is accompanied by a positive attitudinal stance [34]. The importance of DEA as a motivating medium is further reinforced by SyT, which boosts intention only to the extent that it improves attitudes from a TPB standpoint.

According to the TPB (H13: $\beta = 0.777$, $p = 0.000$), DEA significantly and robustly influence DEI. To a greater extent than the direct effects of traits associated with strategic thinking, this result confirms that views of digital entrepreneurship function as the most direct and significant predictor of intention. The size of this effect indicates that college students' intention-forming process is more focused on evaluation than pure cognition. Regardless of students' future-predicting, idea-generating, or information-synthesis abilities, the development of intention depends on the perception of digital entrepreneurship as desirable, feasible, and valuable [5, 12].

A process-oriented interpretation of the TPB is strongly supported by these findings. Rather than directly impacting intention, the components of strategic thinking that precede attitude are ViT, CreT, and SyT. This shows that all three traits have a significant effect on digital entrepreneurship mindsets, but that their effects on actual behavior are mixed.

These findings indicate that DEI is shaped more directly by evaluative judgment than by cognitive capability alone. Strategic thinking represents cognitive readiness, whereas entrepreneurial intention requires motivational commitment. Therefore, the findings highlight the importance of distinguishing between students' ability to think strategically and their willingness to pursue digital entrepreneurship. The need to distinguish between cognitive readiness and motivational commitment in studying digital entrepreneurship is underscored by this selective influence, which challenges reductionist models that assume direct correlations between cognition and intention.

4.3 Mediation analysis

The mediation analysis was conducted to examine the indirect pathways through which strategic thinking shows in Table 10, DEA, SU, and LoC influence DEI. The results show that DEA plays a central mediating role in the formation of

DEI.

Table 10. Mediating effect

Relationship	β	t	p-Value	Results
CreT -> DEA -> DEI	0.133	3.483	0.001	Accepted
SU -> CreT -> DEA -> DEI	0.054	3.526	0.000	Accepted
SU -> ViT -> DEA -> DEI	0.029	2.125	0.034	Accepted
SU -> SyT -> DEI	0.018	1.693	0.091	Rejected
LoC -> ViT -> DEI	0.008	0.553	0.580	Rejected
LoC -> SyT -> DEI	0.019	1.575	0.115	Rejected
LoC -> CreT -> DEI	-0.002	0.201	0.841	Rejected
LoC -> ViT -> DEA -> DEI	0.024	2.054	0.040	Accepted
LoC -> SyT -> DEA -> DEI	0.065	3.883	0.000	Accepted
SU -> ViT -> DEI	0.010	0.561	0.575	Rejected
SU -> CreT -> DEI	-0.003	0.201	0.841	Rejected
SyT -> DEA -> DEI	0.182	4.509	0.000	Accepted
ViT -> DEA -> DEI	0.074	2.136	0.033	Accepted
LoC -> CreT -> DEA -> DEI	0.035	2.855	0.004	Accepted
SU -> SyT -> DEA -> DEI	0.062	4.284	0.000	Accepted

Note: DEA = digital entrepreneurial attitudes; DEI = digital entrepreneurial intention; ViT = visionary thinking; CreT= creative thinking; LoC = locus of control; SU = smartphone use; SyT = synthetic thinking.

First, DEA significantly mediates the relationship between the three dimensions of strategic thinking and DEI. SyT has a significant indirect effect on DEI through DEA (β = 0.182, p < 0.001). This indicates that students' ability to integrate information, evaluate feasibility, and connect technological and market-related knowledge strengthens their intention to engage in digital entrepreneurship when such cognitive ability is translated into a positive entrepreneurial attitude.

CreT also has a significant indirect effect on DEI through DEA (β = 0.133, p = 0.001). This finding suggests that students who are able to generate original and innovative ideas are more likely to develop DEI when they first perceive digital entrepreneurship as desirable, meaningful, and feasible. Similarly, ViT significantly influences DEI through DEA (β = 0.074, p = 0.033). Although this effect is weaker than SyT and CreT, it shows that future-oriented thinking can support entrepreneurial intention when it strengthens students' positive evaluation of digital entrepreneurship.

These findings confirm that strategic thinking does not directly produce DEI. Instead, its influence operates through DEA. Therefore, DEA can be interpreted as a key mediating into entrepreneurial commitment.

Second, the results show significant serial mediation effects from SU to DEI through strategic thinking and DEA. SU significantly influences DEI through CreT and DEA (β = 0.054, p < 0.001), through SyT and DEA (β = 0.062, p < 0.001), and through ViT and DEA (β = 0.02, p = 0.034). These findings indicate that SU may support entrepreneurial intention when digital exposure contributes to strategic thinking and when such strategic thinking is further transformed into positive DEA.

However, the indirect effects of SU on DEI through strategic thinking alone are not significant. SU does not significantly influence DEI through SyT only (β = 0.018, p = 0.091), CreT only (β = -0.003, p = 0.841), or ViT only (β = 0.010, p = 0.575). This suggests that digital exposure through SU is not sufficient to increase entrepreneurial intention unless it is followed by positive attitude formation.

Third, LoC also has significant serial mediation effects on DEI through strategic thinking and DEA. LoC significantly influences DEI through SyT and DEA (β = 0.065, p < 0.001), through CreT and DEA (β = 0.035, p = 0.004), and through ViT and DEA (β = 0.024, p = 0.040). These results indicate that students with a stronger sense of personal control are more likely to develop strategic thinking capabilities, which then shape positive attitudes toward digital entrepreneurship and ultimately strengthen their entrepreneurial intention.

In contrast, LoC does not significantly influence DEI through strategic thinking alone. The indirect effects through SyT only (β = 0.019, p = 0.115), CreT only (β = -0.002, p = 0.841), and ViT only (β = 0.008, p = 0.580) are not significant. This reinforces the argument that psychological resources and cognitive capabilities must be translated into positive entrepreneurial attitudes before they can influence entrepreneurial intention.

Overall, the mediation findings support an attitude-focused extension of the TPB. DEI is not formed directly through SU, LoC, or strategic thinking alone. Rather, intention develops through a layered process in which SU and LoC support strategic thinking, strategic thinking shapes DEA, and DEA strengthens DEI. Therefore, DEA serves as the key mechanism that converts digital exposure and cognitive readiness into entrepreneurial commitment.

4.4 Importance-Performance Map Analysis

The Importance-Performance Map Analysis (IPMA) was conducted to complement the structural model results by comparing the relative importance and performance of the antecedent constructs of DEI. While the structural model identifies statistically significant relationships, IPMA provides additional practical insight into which constructs should be prioritized in educational and policy interventions.

The IPMA results (Figure 3) indicate that DEA has the highest importance in predicting DEI. However, its performance level remains moderate compared with several strategic thinking dimensions. This suggests that DEA represents the most critical intervention point. Although students may already possess certain cognitive capabilities, their evaluative orientation toward digital entrepreneurship still needs to be strengthened.

SyT also shows relatively high importance and performance. This indicates that students are able to integrate information, assess feasibility, and connect technological and market-related knowledge in the context of digital entrepreneurship. However, its influence on intention depends on whether this cognitive capability is translated into a positive DEA.

CreT and ViT show strong performance but relatively lower importance compared with DEA and SyT. This pattern suggests that students may perceive themselves as creative and future-oriented, yet these cognitive capabilities are not fully converted into entrepreneurial intention. Therefore, HEI should design learning activities that connect CreT and ViT with opportunity evaluation, market validation, and digital venture development.

LoC demonstrates strong performance but moderate importance. This indicates that students generally perceive themselves as having control over outcomes, but this psychological resource primarily influences intention indirectly through strategic thinking and DEA. Similarly, SU shows practical relevance as a source of digital exposure, but access to smartphones alone is insufficient to strengthen entrepreneurial intention. SU should therefore be integrated into structured cognitive and attitudinal development programs, such as opportunity recognition tasks, digital market exploration, business model simulation, and entrepreneurship project-based learning.

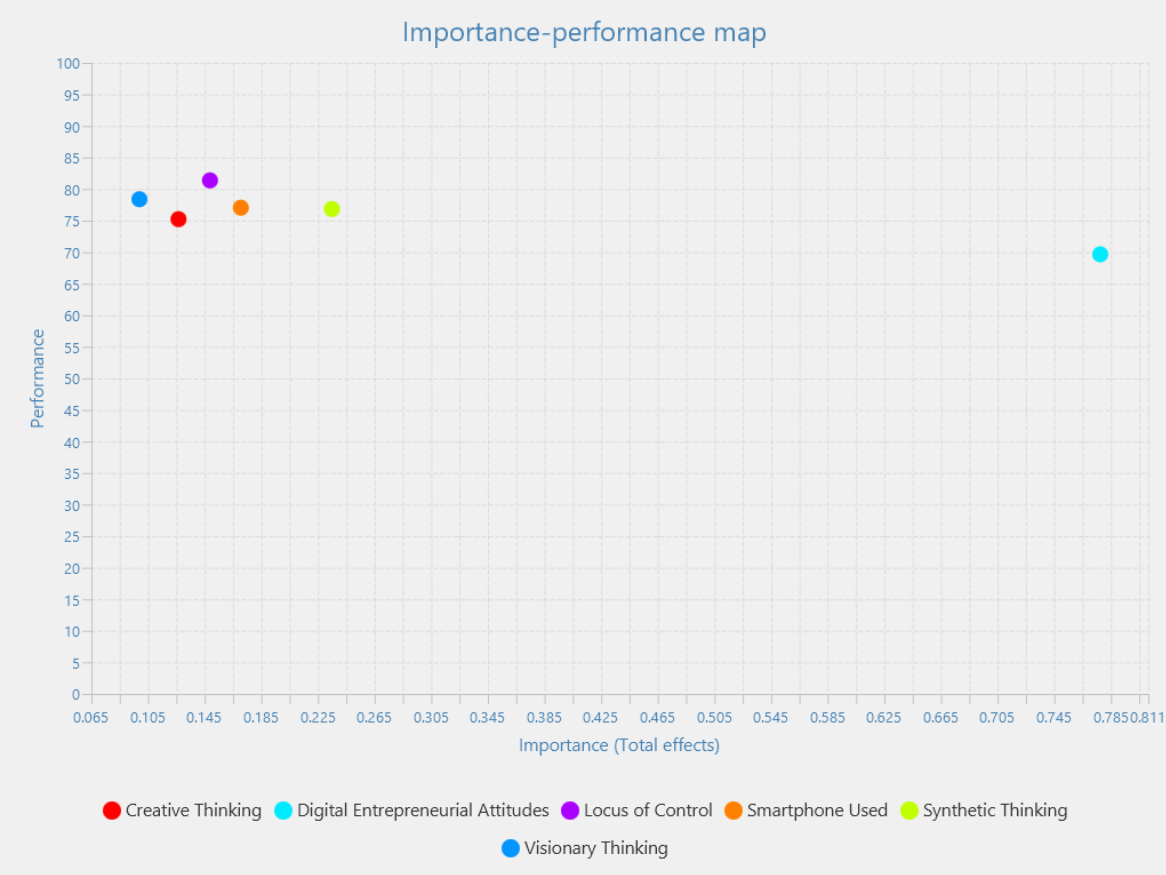

Figure 3. Importance-Performance Map Analysis (IPMA)

5. CONCLUSION

Overall, the IPMA results reinforce the central role of DEA in the proposed model. The findings suggest that universities should prioritize interventions that help students transform digital exposure and strategic cognition into positive evaluations of digital entrepreneurship. Such interventions may include experiential learning, digital business incubation, sustainability-oriented venture design, mentoring, and market validation activities.

DEA emerges as the strongest predictor of DEI. This finding confirms the central role of attitude in the TPB framework and suggests that students are more likely to develop entrepreneurial intention when they perceive digital entrepreneurship as desirable, feasible, meaningful, and relevant to their future.

From a sustainable development planning perspective, the findings highlight the role of HEI in preparing students for digital entrepreneurship. Universities should not only provide digital skills and technological exposure but also design learning environments that integrate strategic thinking, opportunity evaluation, creative problem solving, sustainability-oriented business models, and experiential learning.

This study has several limitations. It does not test the complete TPB model because subjective norms and perceived behavioral control are not included. The cross-sectional design also limits causal interpretation, and the sample is restricted to engineering students in Indonesian HEI. In addition, SU was measured as general usage intensity rather than specific entrepreneurial or learning-oriented use.

Future research should examine the complete TPB framework, include more diverse student populations, and use longitudinal or experimental designs. Further studies may also consider variables such as entrepreneurial self-efficacy, university support, sustainability orientation, perceived behavioral control, subjective norms, and entrepreneurial identity.

In conclusion, DEI is not formed automatically through digital exposure or strategic thinking. It develops when students' cognitive capabilities are translated into positive attitudes toward digital entrepreneurship. This study therefore emphasizes the importance of connecting digital exposure, strategic thinking, attitude formation, and entrepreneurial commitment within higher education.

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