The object of this research is women-led small and medium enterprises (SMEs) located in five sub-districts of Solo City, Indonesia. Women-led small and medium enterprises (SMEs) in Indonesia face unresolved gaps in understanding how digital transformation (BDT), hard and soft skills (HSS), and innovative digital ideas (IDI) to behavioral intention (BIu) and digital entrepreneurship decisions (DEDc). To address this problem, a comprehensive structural equation modeling (SEM) framework was employed to analyze the effects of BDT, HSS, and IDI on BIu and DEDc. Findings indicate that BDT strengthens BIu and directly drives the DEDc. In contrast, HSS and IDI significantly enhance BIu, serving as an essential construct that translates HSS and IDI into concrete decisions. BIu emerged as the principal determinant of digital entrepreneurship choices, underscoring that competency development and innovation must be complemented by measures that cultivate commitment, proactiveness, and strategic preparation. BDT, HSS, and IDI significantly bolster BIu, the primary DEDc driver, with BDT. The model explained 79.1% of BIu variance and 57.3% of DEDc variance, with strong predictive relevance ($Q^2 > 0.35$). The underlying model explains a substantial share of variance in BIu and DEDc, confirming the robustness and validity of the employed constructs. These insights highlight that women-led SMEs can effectively implement and sustain digital initiatives under supportive policy frameworks and targeted training programs focused on leadership-driven transformation, comprehensive skill development, and ideation workshops. This SEM framework offers practitioners and policymakers a practical guide for prioritizing interventions that enhance digital readiness and entrepreneurial intention among women entrepreneurs in Indonesia and analogous emerging-market contexts

Keywords: digital transformation, skills, innovation, behavioral intentions, entrepreneurship, SMEs, women, technology, strategy, policy

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DIGITAL ENTREPRENEURSHIP DECISIONS IN INDONESIAN WOMEN-LED SMES: AN INTEGRATED SEM OF TRANSFORMATION, SKILLS, INNOVATION, AND BEHAVIORAL INTENTION

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1. Introduction

Women entrepreneurs are crucial in promoting economic development and social cohesion in Indonesia. Their entrepreneurial activities drive commercial success and contribute significantly to poverty alleviation, innovation, and more equitable economic participation. Despite their potential, female entrepreneurs face substantial challenges-including limited access to financial resources, markets, networks, knowledge, and the burden of gendered cultural expectations-that hinder sustainable business growth and exacerbate gender disparities in entrepreneurship [1].

In today's rapidly digitalizing global economy, BDT has emerged as a key facilitator in overcoming these obstacles. Advances in digital technologies enable firms to enhance efficiency, extend market reach, and foster creativity. Research [2] confirms that adopting digital technologies increases corporate resilience, adaptability, and sustainable growth. However, DEDc without a solid foundation in technical and soft competencies can lead to suboptimal outcomes, even undermining Firm Performance [3]. Moreover, BIu is widely recognized as a critical precursor to successful digital adoption [4], influencing entrepreneurs' readiness to embrace and integrate digital solutions within their operations [5].

Despite these acknowledged benefits, there remains a significant gap in understanding how BIu, combined with complementary factors such as BDT, HSS and IDI, influences DEDc – particularly within the context of women-led SMEs in Indonesia. Current literature presents conflicting findings [6]: while some studies highlight clear advantages of digital adoption, others indicate ambiguous or adverse effects [7]. This divergence calls for a deeper investigation into how these elements interact and support the decision-making process in digital entrepreneurship.

The importance of this research topic is underscored by the need to align the advancements in digital technologies with practical strategies that empower women entrepreneurs. As science and technology evolve, it is necessary to continually reassess and update the understanding of digital entrepreneurship to ensure that theoretical developments translate into effective and sustainable business practices. The dynamic nature of digital innovation and the persistent challenges women-led SMEs face make it imperative to reexamine and refine existing models to provide clear guidelines for policymakers and practitioners.

Understanding how BDT, HSS, IDI, and BIu interact to shape DEDc has become imperative in today's digital economy. In a cross-country study, the opportunity-based female entrepreneurship rate in Indonesia was recorded at 9.3% compared to the global average of 11.7% [1], while the women's empowerment index explained 18% of the variation in GDP growth [2]. Closing this adoption gap requires a granular grasp of digital-entrepreneurial intention and decision-making drivers so policymakers and training providers can craft precise, inclusive interventions that empower women entrepreneurs and strengthen SME competitiveness globally.

2. Literature review and problem statement

BDT has emerged as a crucial catalyst for entrepreneurial innovation, revolutionizing business models and enhancing operational efficiency across various sectors. Although the existing literature has extensively examined aspects of BDT and entrepreneurship separately, significant gaps remain in understanding the interplay between BDT, HSS, IDI, and BIu in influencing DEDc [8–10]. For instance, a study [8] demonstrated that BDT improves operational efficiency; but did not investigate the influence of HSS or BIu within this process. Similarly, a study [9] established a positive relationship between BDT and corporate performance, yet it overlooked the impact of new digital concepts, likely due to the challenges of isolating intangible variables.

Previous research has contributed by outlining various conceptual frameworks and research trajectories [10]; however, these studies address digital entrepreneurship's components in isolation. This fragmentation has resulted in a limited understanding of the causal mechanisms underpinning DEDc, particularly among small and medium enterprises (SMEs). While research on digital competencies has emphasized the importance of technical proficiency, problem-solving, communication, and adaptable soft skills in shaping attitudes and perceived behavioral control, the mechanisms by which these competencies influence entrepreneurial ambitions remain inadequately explored, especially in SMEs outside international or academic environments.

Moreover, although the COVID-19 pandemic has accelerated digitalization as a driver of innovation [11–13], most studies in this context have prioritized rapid innovation uptake without establishing a robust theoretical framework to understand the psychological and competency-related precursors [11]. An integrated analytical approach, such as structural equation modeling (SEM), has not been comprehensively applied to examine the interactions among these variables [12]. Therefore, there is an urgent need to develop a model that integrates BDT, HSS, and IDI and explains how BIu impacts DEDc [13]. Despite acknowledging the importance of digital skills (technical proficiency, problem-solving) and soft skills (communication, adaptability) [11–13], no study holistically examines BDT, HSS, and IDI interact with BIu to drive entrepreneurial decisions in SMEs.

However, it frequently emphasizes the prompt adoption of innovations over a theoretical investigation of the precursors to DEDc [14–16]. Research by [14] offers comprehensive insights into BDT, sustainable development, and open innovation. Although these studies provide valuable conceptual frameworks, they do not explicitly examine the decision-making processes behind BDT, specifically how HSS, IDI, and BIu intersect to affect entrepreneurial outcomes. Research by [15] investigated the impact of digitization on entrepreneurial endeavors and sustained competitiveness, highlighting the differing importance of digital skills, connectivity, and integration. HSS, especially digital capabilities, are essential for DEDc. Nonetheless, the processes by which digital competencies influence entrepreneurial decision-making are inadequately investigated, resulting in a research void. Bibliometric research by [16] examined scholarly works from 2010 to 2023. Despite this consistent advancement in conceptual frameworks, a vacuum persists in examining the mechanisms by which digital skills affect entrepreneurial ambition.

Although numerous studies have revealed partial relationships among BDT, HSS, and IDI, these investigations have yet to integrate these factors within a comprehensive conceptual framework. This limitation has resulted in a constrained understanding of the holistic mechanisms driving BIu and DEDc, particularly within SMEs that face resource constraints and distinctive operational challenges. The integrated model proposed in this study seeks to bridge this gap by combining BDT, HSS, IDI, and BIu measures through SEM. This approach identifies the direct effects among the variables that have received insufficient attention in prior research.

The literature reveals a fragmentation in the examination of factors related to DEDc. There is insufficient investigation into how BDT, HSS, IDI, and BIu influence these factors on DEDc. The lack of an integrated framework limits the development of targeted strategies for enhancing digital competencies within SMEs. Previous studies have primarily addressed these factors in isolation and have not provided an integrative SEM framework that systematically examines:

a) the effects of BDT, HSS, and IDI on BIu;

b) the direct effects of BDT, HSS, IDI, and BIu on DEDc;

c) provides empirical evidence that can guide policymakers and practitioners in designing effective strategies to strengthen digital competencies and foster digital entrepreneurship.

3. The aim and objectives of the study

This study aims to develop and validate a SEM framework that comprehensively explains the impact of BDT, HSS, IDI, and BIu on DEDc. The model is expected to offer both theoretical and practical contributions by integrating variables that have been previously studied in isolation, and by providing empirical evidence to enhance digital adoption in Indonesian SMEs.

To achieve this aim, the following objectives are accomplished:

– to analyze the impact of BDT on BIu and DEDc;
– to analyze the impact of HSS on BIu and DEDc;
– to analyze the impact of IDI on BIu and DEDc;
– to identify the direct effects of BIu on DEDc.

4. Materials and methods

4. 1. Object and hypotheses of the study

The object of this study is women-led small and medium enterprises (SMEs) located in five sub-districts of Solo City, Indonesia. This study examines the influence of BDT, HSS, IDI, and BIu on DEDc. The research hypotheses are formulated as follows: The hypotheses developed include: H1.a – BDT positively influences BIu; H1.b – BDT positively influences DEDc; H2.a – HSS positively influence BIu; H2.b – HSS positively influence DEDc; H3.a – IDI positively influence BIu; H3.b – IDI positively influence DEDc; and H4 – BIu positively affects DEDc.

Assumptions made in the study. Several assumptions underlie this study's design and analysis. First, the measurement model assumes a reflective structure, where observed indicators are manifestations of underlying latent constructs such as BDT, HSS, IDI, BIu, and DEDc. The relationships among these constructs are assumed to be linear and additive, reflecting the standard assumptions in structural equation modeling. Moreover, causality is presumed to flow unidirectionally from exogenous variables (BDT, HSS, IDI) to BIu and DEDc without modeling reciprocal effects. The study also assumes independence among observations, meaning each respondent's data represents a unique, unbiased view. While self-reported data introduces the potential for standard method variance, it is assumed to be minimal due to careful survey design and procedural remedies.

Simplifications adopted in the study. The scope of the study is limited to Solo City, which, while allowing for contextual depth, restricts the generalizability of the findings to broader in Indonesia. Using a cross-sectional design limits the ability to conclude changes over time. Additionally, the model does not include external environmental factors such as government policy support, competitive intensity, and infrastructure availability, even though they may influence entrepreneurial decisions. Finally, the model structure is theory-driven and fixed, without exploring interaction effects or alternative pathways, to preserve clarity and parsimony in the structural equation framework.

4. 2. Population, sampling, and measurement instruments

The research focused on five sub-districts in Solo City (Pasar Kliwon, Jebres, Banjarsari, Laweyan, and Serengan) using a stratified random sampling method to ensure diversity. 337 valid responses from women-led SMEs were collected, meeting SEM analysis requirements. All items were measured using a 5-point Likert scale. BDT was measured using four items: evaluating confidence (BDT1), proactiveness (BDT2), success drive (BDT3), and leadership in managing digital businesses (BDT4) adopted from [17], HSS using four items: covering technical proficiency (HSS1), organization (HSS2), communication (HSS3), and risk-taking (HSS4) from [18], IDI using three items: reflecting process (IDI1), product/service (IDI2), and market innovations (IDI3) from [19], BIu using three items: assessing determination (BIu1), commitment (BIu2), and strategic preparation (BIu3) from [20], and DEDc using four items: focusing on efficiency (DEDc1), optimization (DEDc2), revenue growth (DEDc3), and business expansion (DEDc4) from [21].

4. 3. Data preprocessing

Before conducting the analysis, several preprocessing steps were taken. Data cleaning was performed to remove inconsistent or incomplete responses. The survey design ensured there were no missing values. Outliers were assessed using Mahalanobis distance and boxplots, resulting in the removal of 8 extreme values. While PLS-SEM does not assume normal data distribution, descriptive statistics confirmed acceptable skewness and kurtosis values.

4. 4. Data analysis procedure

The analysis was conducted using SmartPLS version 4.1.0.8, following the standard two-step approach: measurement model evaluation and structural model evaluation. The measurement model assessed indicator reliability (outer loadings > 0.7), construct reliability (Cronbach's alpha and Composite reliability > 0.7), convergent validity (AVE > 0.5), and discriminant validity using both the Fornell-Larcker criterion and HTMT ratio (<0.9). Bootstrapping with 5,000 subsamples was conducted to test the significance of path coefficients. Hypotheses were accepted if the p-value was below 0.05. The model's explanatory power was assessed using R^2 values, effect size (f^2), and predictive relevance (Q^2), ensuring robust and reliable results [22].

4. 5. Hypothesis testing

To determine the acceptance or rejection of hypotheses, significance levels from the structural model were interpreted using standard thresholds. Additionally, within the SmartPLS bootstrapping procedure (Fig. 1).

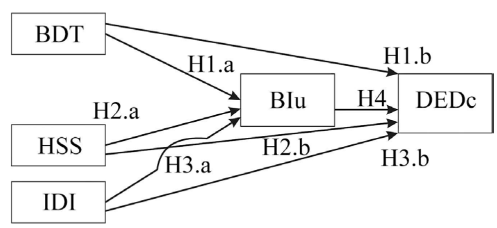

Fig. 1. Research concept

Fig. 1 illustrates the conceptual framework of this study, which examines the effects of BDT, HSS, and IDI on BIu and DEDc. This model emphasizes the importance of these factors in shaping BIu and driving DEDc within SMEs operating in a dynamic digital environment.

5. Research findings: impact of BDT, HSS, IDI, and BIu on DEDc

5. 1. Impact of BDT on BIu and DEDc

The first objective examined how the breadth of BDT influences BIu and DEDc. Before hypothesis testing, all measurement items for BDT exhibited strong indicator reliability, with factor loadings ranging from 0.869 to 0.920 (Table 1 and Fig. 2). Construct reliability was confirmed by Cronbach's Alpha (0.913) and composite reliability (0.915), while convergent validity was demonstrated by an AVE (0.794), exceeding the 0.50 threshold. Discriminant validity assessed via the Fornell–Larcker criterion (Table 2) and HTMT ratios (Table 3) showed that the BDT construct AVE square root surpassed its inter-construct correlations, affirming empirical distinctiveness. The results of factor loadings and reliability metrics are presented in Table 1 and Fig. 2.

As shown in Table 1 and Fig. 2, all indicator loadings exceeded the recommended threshold of 0.70, ranging from 0.768 to 0.920, indicates that the observed variables strongly represent their respective latent constructs, satisfying the criteria for indicator reliability as suggested by [22]. Construct reliability was assessed through both Cronbach's Alpha and composite reliability (CR). All constructs demonstrated Cronbach's Alpha values above 0.70, ranging from 0.778 to 0.913, which signifies acceptable internal consistency. Similarly, the composite reliability values for all constructs were well above the threshold of 0.70, indicating a high measurement stability and internal coherence level. All constructs achieved AVE values greater than the recommended minimum of 0.50, ranging from 0.672 to 0.794. These results confirm that each construct captures more than 50% of its indicators' variance, meeting the requirement for convergent validity.

Table 1

Factor loadings

Constructs	Items	Factor loadings	Cronbach's Alpha	Composite reliability	AVE
BDT	BDT1	0.882	0.913	0.915	0.794
	BDT2	0.891			
	BDT3	0.920			
	BDT4	0.869			
HSS	HSS1	0.819	0.890	0.904	0.752
	HSS2	0.887			
	HSS3	0.879			
	HSS4	0.882			
IDI	IDI1	0.885	0.857	0.859	0.778
	IDI2	0.875			
	IDI3	0.886			
BIu	BIu1	0.799	0.778	0.786	0.693
	BIu2	0.876			
	BIu3	0.820			
DEDc	DEDc1	0.768	0.837	0.840	0.672
	DEDc2	0.867			
	DEDc3	0.811			
	DEDc4	0.829			

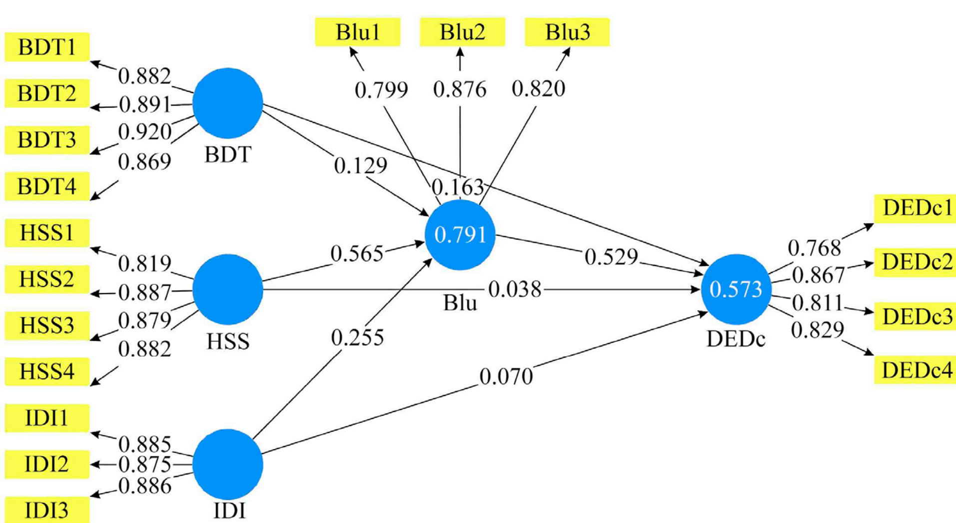

Fig. 2. Structural equation modeling output algorithms analysis

Discriminant validity is evaluated using cross-loading, wherein an indicator is deemed valid if its loading factor exceeds that of other variables. The Fornell-Larcker Criterion assesses discriminant validity at the variable level, as seen in Table 2.

Table 2

Fornell-Lacker criterion and average variance extracted

Constructs	AVE	Correlation between variables				
		BDT	BIu	DEDc	HSS	IDI
BDT	0.794	**0.891**	–	–	–	–
BIu	0.693	0.785	**0.833**	–	–	–
DEDc	0.672	0.662	0.745	**0.820**	–	–
HSS	0.752	0.825	0.867	0.685	**0.867**	–
IDI	0.778	0.744	0.785	0.636	0.768	**0.882**

Table 2 presents the results of the square roots of the AVE values, shown on the diagonal, which are greater than the corresponding correlations between constructs in their respective rows and columns, indicating that each construct is empirically distinct from the others. The discriminant validity results reveal that all diagonal values are higher than any other correlation coefficients in the same row or column. The highest inter-construct correlation is observed between HSS and BIu at 0.867. Although this value approaches the square root of AVE for both constructs (0.867 for HSS and 0.833 for BIu), it still satisfies the discriminant validity criterion. The Heterotrait-Monotrait ratio (HTMT) is used in PLS-based analysis to assess construct distinctiveness, as seen in Table 3.

Table 3

Heterotrait-Monotrait ratio

Constructs	BDT	BIu	DEDc	HSS
BIu	**0.929**	–	–	–
DEDc	0.743	**0.908**	–	–
HSS	0.910	1.025	**0.777**	–
IDI	0.839	0.960	0.740	**0.866**

The HTMT results indicate that most values fall within the acceptable range, thus confirming discriminant validity among the constructs. The highest HTMT value is observed between HSS and BIu, at 1.025, which slightly exceeds the conservative threshold of 0.90 and the more lenient threshold of 0.95, suggests a potential concern regarding the discriminant validity between HSS and BIu, indicating that these two constructs are highly correlated and may share overlapping conceptual content. However, given the theoretical justification, the context of the study, and the acceptable HTMT values of the other construct pairs, this issue may be tolerable for exploratory research in a behavioral science setting [23].

To test H1.a and H1.b, examined the direct effects of BDT on BIu and DEDc. Table 4 summarizes these relationships' bootstrapped path coefficients, *t*-statistics, and *p*-value.

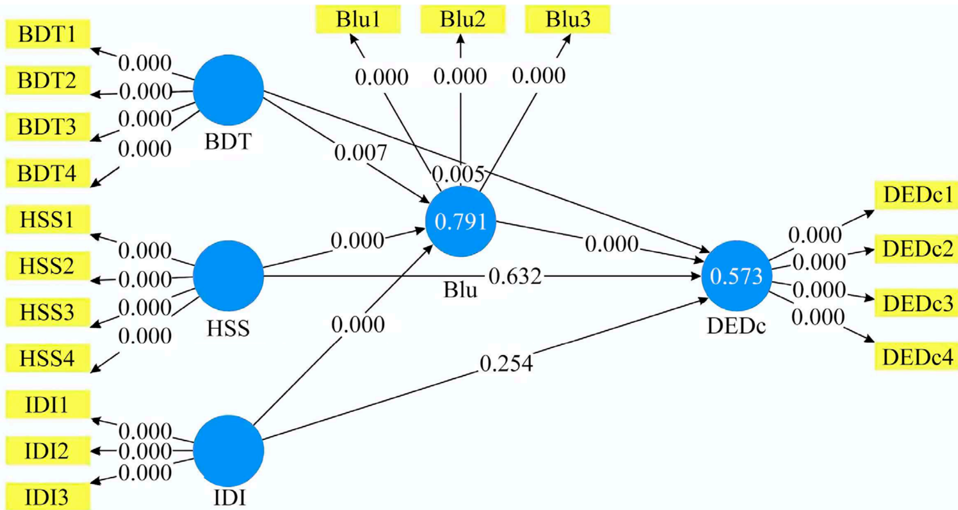

Fig. 3. Structural equation modeling output bootstrapping analysis

Table 4

Hypotheses testing results for BDT

Relationships	β	t-statistics	p-value	Decision
BDT→BIu	0.129	2.712	0.007	H1.a Supported
BDT→DEDc	0.163	2.803	0.005	H1.b Supported

Table 4 and Fig. 3 present the analysis revealing that BDT significantly positively affects BIu ($\beta = 0.129$; $t = 2.712$; $p = 0.007$), supporting H1a. BDT also significantly influences DEDc ($\beta = 0.163$; $t = 2.803$; $p = 0.005$), thereby supporting H1b.

5. 2. Impact of HSS on BIu and DEDc

The second objective examined how the breadth of HSS influences BIu and DEDc. Before hypothesis testing, all measurement items for HSS exhibited strong indicator reliability, with factor loadings ranging from 0.819 to 0.887 (Table 1 and Fig. 2). Construct reliability was confirmed by Cronbach's Alpha (0.890) and composite reliability (0.904), while convergent validity was demonstrated by an AVE (0.752), exceeding the 0.50 threshold. Discriminant validity assessed via the Fornell–Larcker criterion (Table 2) and HTMT ratios (Table 3) showed that the HSS construct AVE square root surpassed its inter-construct correlations, affirming empirical distinctiveness.

Hypotheses H2.a and H2.b assessed the influence of HSS on BIu and DEDc. Table 5 below displays the results specific to HSS.

Table 5

Hypotheses testing results for HSS

Relationships	β	t -statistics	p-value	Decision
HSS→BIu	0.565	11.646	0.000	H2.a supported
HSS→DEDc	0.038	0.479	0.632	H2.b not supported

HSS demonstrates a significant positive effect on BIu ($\beta = 0.565$; $t = 11.646$; $p = 0.000$), supporting H2.a. HSS significantly and positively affects BIu. This underscores that proficiency in technical competencies and interpersonal capabilities is the most critical predictor of women entrepreneurs' intention to use digital technologies. However, HSS does not directly affect DEDc significantly ($\beta = 0.038$; $t = 0.479$; $p = 0.632$), indicating that H2.b is unsupported. Conversely, HSS does not exhibit a significant direct effect on DEDc, leading to the rejection of H2.b. Fig. 3 also illustrates the non-significant direct path from HSS to DEDc.

5. 3. Impact of IDI on BIu and DEDc

The third objective examined how the breadth of IDI influences BIu and DEDc. Before hypothesis testing, all measurement items for IDI exhibited strong indicator reliability, with factor loadings ranging from 0.875 to 0.886 (Table 1 and Fig. 2). Construct reliability was confirmed by Cronbach's Alpha (0.857) and composite reliability (0.859), while convergent validity was demonstrated by an AVE (0.778), exceeding the 0.50 threshold. Discriminant validity assessed via the Fornell–Larcker criterion (Table 2) and HTMT ratios (Table 3) showed that the IDI construct AVE square root surpassed its inter-construct correlations, affirming empirical distinctiveness.

To evaluate H3.a and H3.b, the effects of IDI on BIu and DEDc were analyzed. Table 6 presents the bootstrapped estimates for IDI.

Table 6

Hypotheses testing results for IDI

Relationships	β	t-statistics	p-value	Decision
IDI→BIu	0.255	5.344	0.000	H3.a supported
IDI→DEDc	0.070	1.142	0.254	H3.b not supported

IDI significantly affects BIu ($\beta = 0.255$; $t = 5.344$; $p = 0.000$), confirming H3.a. Hypothesis testing affirms H3.a: IDI significantly shapes BIu. This indicates that IDI within SMEs bolsters women entrepreneurs' motivation to engage with and utilize digital technologies. In contrast, the direct effect of IDI on DEDc is not significant ($\beta = 0.070$; $t = 1.142$; $p = 0.254$), leading to the rejection of H3.b.

5. 4. Impact of BIu on DEDc

The last objective examined how the breadth of BIu influences DEDc. Before hypothesis testing, all measurement items for BIu exhibited strong indicator reliability, with factor loadings ranging from 0.799 to 0.876 (Table 1 and Fig. 2). Construct reliability was confirmed by Cronbach's Alpha (0.778) and composite reliability (0.786), while convergent validity was demonstrated by an AVE (0.693), exceeding the 0.50 threshold. Discriminant validity assessed via the Fornell–Larcker criterion (Table 2) and HTMT ratios (Table 3) showed that the BIu construct AVE square root surpassed its inter-construct correlations, affirming empirical distinctiveness.

Hypothesis H4 examined the role of BIu on DEDc. Table 7 presents the bootstrapped estimates for BIu.

BIu significantly affects DEDc ($\beta = 0.529$; $t = 6.457$; $p = 0.000$), confirming H4. Fig. 3 confirms the robustness of this relationship in the bootstrapped SEM analysis. The structural model confirmed that BIu is the strongest direct predictor of DEDc. This result highlights that women entrepreneurs' intention to use digital technologies is a pivotal driver of their capacity to make effective digital entrepreneurship decisions. The outcomes of these evaluations are presented in Table 8.

Table 7

Hypotheses testing results for BIu

Relationships	β	*t*-statistics	*p*-value	Decision
BIu → DEDc	0.529	6.457	0.000	H4 Supported

Table 8

Explanatory power

Predictor(s)	Outcome(s)	R-square	R-square adjusted	f-square	Q-square predict
BDT	BIu	0.791	0.789	0.023	0.782
HSS				0.406	
IDI				0.116	
BDT	DEDc	0.573	0.567	0.018	0.498
HSS				0.001	
IDI				0.004	
BIu				0.137	

The R^2 value for BIu is 0.791, with an adjusted R^2 of 0.789, indicates that BDT, HSS, and IDI collectively explain 79.1% of the variance in BIu. According to [22], an R^2 value above 0.75 is considered substantial. Therefore, the explanatory power of the model for BIu is considered significant. HSS have a large effect size ($f^2 = 0.406$) on BIu, highlighting the importance of skill enhancement in influencing BIu. BIu shows a small but meaningful effect size ($f^2 = 0.137$) on DEDc. BDT and IDI exhibit small effect sizes on BIu but negligible effect sizes on DEDc. HSS and IDI display almost no direct effect on DEDc. The findings indicate that BIu has a Q^2 value 0.782, while DEDc has a Q^2 value 0.498. Both Q^2 values exceed the threshold of 0.35, indicating that the model demonstrates strong predictive relevance. These results confirm that the exogenous constructs in the model possess a high ability to predict the endogenous constructs.

6. Discussion of the results of the study of digital entrepreneurship decisions in Indonesian women-led SMEs

The integrated SEM framework demonstrates clear linkages between measurement validity, structural paths, and the interpretation of each research objective. For the first objective, as shown in Table 1 and Fig. 2, BDT's measurement properties (factor loadings 0.882–0.920; Cronbach's $\alpha = 0.913$; AVE = 0.794) ensure construct reliability. Hypothesis results in Table 4 and Fig. 3 indicate BDT's significant effects on BIu ($\beta = 0.129$; $p = 0.007$) and DEDc ($\beta = 0.163$; $p = 0.005$), confirming that BDT breadth enhances both BIu and DEDc. Bootstrapping analysis (Table 4, Fig. 3) revealed that BDT significantly positively influences BIu, thereby supporting H1.a. This finding indicates that as Indonesian women-led SMEs engage more extensively in digital transformation initiatives, such as adopting cloud platforms, digital marketing channels, and process automation, their intention to leverage these tools in entrepreneurial activities correspondingly increases. Moreover, BDT showed a significant direct effect on DEDc, supporting H1.b. This suggests that broader BDT motivates the usage of BIu and directly enhances DEDc capacity within the digital entrepreneurship ecosystem, potentially by expanding access to data-driven insights and network resources.

Regarding the second objective, HSS were validated in Table 1 and Fig. 2 (loadings 0.819–0.887; $\alpha = 0.890$; AVE = 0.752), and Table 5 with Fig. 3 show a substantial impact on BIu ($\beta = 0.565$; $p = 0.000$) but no direct effect on DEDc ($\beta = 0.038$; $p = 0.632$), this underscores the role of intention in translating competencies into decisions. HSS emerged as the single strongest predictor of BIu, confirming that staff competencies are the primary lever for motivating digital adoption, yet these skills themselves do not translate into strategic choices without that motivational pathway [24]. Finally, in contrast to prior SME studies focused solely on adoption metrics, this study demonstrates that HSS promotes BIu, thus closing the loop from digital readiness to entrepreneurial action [25].

For the third objective, IDI's robust measurement (Table 1, Fig. 2) and hypothesis test (Table 6, Fig. 3) reveal that IDI significantly drives BIu ($\beta = 0.255$; $p = 0.000$) yet does not significant influence DEDc ($\beta = 0.070$; $p = 0.254$), demonstrating that novel digital ideas increase entrepreneurial capacity only by strengthening intention.

Finally, for the fourth objective, BIu's measurement and discriminant validity are supported by Table 1 and Fig. 2, and Table 7 with Fig. 3 confirm its pivotal role in DEDc ($\beta = 0.529$; $p = 0.000$). The overall explanatory power (Table 8) and predictive relevance (Q^2) further substantiate the model's robustness. By explicitly referencing tables and figures, clarify how each antecedent construct is validated and how its paths contribute to DEDc. These interpretations offer practical insights for policymakers and training providers aiming to strengthen digital readiness and intention among women-led SMEs.

Despite these contributions, several limitations must temper the study's conclusions. First, the cross-sectional survey design constrains causal inference; although SEM allows for directional hypotheses, a single timepoint cannot definitively establish temporal order [26]. Second, the exclusive focus on Indonesian women-led SMEs may limit transferability to other cultural or institutional contexts where gender norms and ecosystem maturity differ [27]. Third, reliance on self-reported measures introduces common-method and social-desirability bias, potentially inflating path coefficients [28]. Finally, the marginal HTMT value (1.025) between HSS and BIu suggests some conceptual overlap, indicating that future measurement development should aim for sharper discriminant validity between competency and intention constructs.

Beyond these methodological constraints, there are three key shortcomings exist in the operationalization. Potential moderators such as firm size, market turbulence, or access to finance that could condition the strength of the observed effects were not examined. While robust for idea generation, the IDI scale did not capture subsequent ideation phases (prototyping, implementation) or ecosystem support, which may explain its lack of direct impact on DEDc [29]. Finally, psychological antecedents (e.g., digital self-efficacy, risk tolerance, proactive personality), which behavioral theory suggests could meaningfully shape BIu and decision outcomes, were omitted.

Future research should employ longitudinal or experimental designs to validate causal sequences from BDT, HSS, and IDI through BIu to DEDc to build on this work and address these gaps. Objective performance metrics such as revenue growth, digital sales share, or number of implemented digital initiatives would reduce self-report bias and demonstrate real-world impact. Comparative studies across industries and cultural settings can test boundary conditions and enhance external validity. At the same time, the inclusion of moderators like ecosystem maturity will reveal when digital readiness factors are most potent. Finally, integrating refined IDI measures that span ideation to implementation and adding psychological traits to the model will enrich explanatory power and offer practitioners precise leverage points for training, policy design, and ecosystem development in women-led digital entrepreneurship.

7. Conclusion

1. PLS-SEM analysis confirms that BDT positively influences BIu ($\beta = 0.129$; $t = 2.712$; $p = 0.007$) and exerts a direct effect on DEDc ($\beta = 0.163$; $t = 2.803$; $p = 0.005$), supporting H1a and H1b. A five-construct PLS-SEM model was validated, demonstrating robust convergent validity (AVE > 0.67) and discriminant validity, ensuring that the BDT measures capture sustainable transformation practices. Unlike prior work focusing solely on performance outcomes, results obtained demonstrate that digital transformation initiatives can directly catalyze strategic entrepreneurship decisions.

2. HSS shows a large effect on BIu ($\beta = 0.565$; $t = 11.646$; $p < 0.001$; $f^2 = 0.406$) but no significant direct impact on DEDc ($\beta = 0.038$; $t = 0.479$; $p = 0.632$), confirming H2a and rejecting H2b. HSS does not translate into decisions, echoing the Theory of Planned Behavior. Policymakers should invest in targeted digital skills programs that explicitly foster entrepreneurial mindsets rather than only technical competencies.

3. IDI significantly predicts BIu ($\beta = 0.255$; $t = 5.344$; $p < 0.001$; $f^2 = 0.116$) but not DEDc directly ($\beta = 0.070$; $t = 1.142$; $p = 0.254$), supporting H3a and rejecting H3b. IDI was operationalized through a three-item scale: reflecting process, product/service, and market innovations. Interventions should pair ideation workshops with intention-building activities to ensure that creative ideas produce concrete entrepreneurial actions.

4. BIu exerts a strong direct influence on DEDc ($\beta = 0.529$; $t = 6.457$; $p < 0.001$; $f^2 = 0.137$), accounting for 57.3 % of its variance ($R^2 = 0.573$) and demonstrating strong predictive relevance ($Q^2 = 0.498$), confirms H4. BIu emerges as the principal driver of DEDc, validating the model proposed in this study and aligning with prior findings on entrepreneurial intention. Integrating BDT, HSS, IDI, BIu, and DEDc into a unified PLS-SEM framework provides a replicable model for future research on digital entrepreneurship. Rigorous validation of measurement scales and reporting of R^2, f^2, and Q^2 values ensure transparency and confirm the robustness of the study's conclusions.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

Data will be made available on reasonable request.

Use of artificial intelligence

The authors have used artificial intelligence technologies within acceptable limits to provide their own verified data, which is described in the research methodology section.

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