Predicting Entrepreneurial Resilience and Sustainable Growth Intentions Among Women Entrepreneurs Through Explainable Artificial Intelligence: An Xgboost-Shap Analytics Approach

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ABSTRACT

Women entrepreneurs play a crucial role in fostering economic development, innovation, and inclusive growth, however, sustaining long-term business growth remains a significant challenge due to technological, psychological, and environmental constraints. This study investigates the determinants of Sustainable Growth Intention (SGI) among women entrepreneurs by developing an integrated framework comprising Digital Entrepreneurial Capability (DEC), Entrepreneurial Psychological Capital (EPC), Innovation Agility (IA), Entrepreneurial Ecosystem Support (EES), and Business Adaptability Capability (BAC). Based on the Resource-Based View and Dynamic Capability Theory, the study examines the direct and indirect relationships among these constructs.

A quantitative research design was employed using survey data collected from women entrepreneurs operating across Southern Rajasthan, India. The proposed framework was evaluated through Structural Equation Modeling (SEM), while Explainable Artificial Intelligence (XAI) techniques, including Extreme Gradient Boosting (XGBoost) and SHapley Additive exPlanations (SHAP), were utilized to enhance predictive accuracy and model interpretability. The findings reveal that DEC ($\beta = 0.238$, $p < 0.001$), EPC ($\beta = 0.281$, $p < 0.001$), IA ($\beta = 0.197$, $p < 0.001$), and EES ($\beta = 0.171$, $p < 0.001$) significantly influence Business Adaptability Capability. Furthermore, BAC exerts a substantial positive effect on Sustainable Growth Intention ($\beta = 0.634$, $p < 0.001$) and significantly mediates all proposed relationships. The model explains 59.2% of the variance in BAC and 53.4% of the variance in SGI. From a predictive perspective, XGBoost outperformed conventional regression and SEM prediction models, achieving an R^2 of 0.748. SHAP analysis identified BAC as the most influential predictor of SGI, followed by EPC, DEC, IA, and EES.

Study contributes to entrepreneurship literature by integrating explanatory and predictive analytical approaches and offers practical insights for policymakers and entrepreneurship-support institutions seeking to strengthen the sustainable growth potential of women-owned enterprises.

Keywords: Women Entrepreneurship, Sustainable Growth Intention, Business Adaptability Capability, Digital Entrepreneurial Capability, Entrepreneurial Psychological Capital, Innovation Agility, Entrepreneurial Ecosystem Support, Structural Equation Modeling, XGBoost, SHAP, Explainable Artificial Intelligence.

INTRODUCTION

Women-owned enterprises have become an important source of employment generation, innovation, and socio-economic development across both developed and emerging economies. Beyond their economic contribution, women entrepreneurs often play a vital role in fostering inclusive growth, supporting community development, and expanding opportunities for underrepresented groups. Despite these contributions, women continue to

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encounter barriers related to finance, technology adoption, business networks, and institutional support, which may restrict business growth and long-term sustainability (Fayaz et al., 2023; Salamzadeh et al., 2024).

The growing digitalization of markets has further transformed the entrepreneurial landscape (Adholiya & Adholiya, 2019). Traditional sources of competitive advantage, such as financial resources and industry experience, are increasingly complemented by digital capabilities, innovation-oriented practices, and the ability to respond quickly to changing market conditions. Digital technologies have enabled entrepreneurs to access wider markets, improve customer engagement, and develop more flexible business models. For women entrepreneurs in particular, digital platforms can help overcome geographical, social, and institutional constraints that have historically limited business opportunities (Salamzadeh et al., 2024; Taheri, 2024). In such dynamic environments, adaptability has become a critical entrepreneurial capability. Business success is no longer determined solely by the availability of resources but also by the entrepreneur's ability to adjust strategies, reconfigure resources, and respond effectively to uncertainty. Research increasingly suggests that entrepreneurs who can adapt to changing environments are better positioned to sustain operations, recover from disruptions, and pursue growth opportunities over time (Khodor et al., 2024; Adholiya et al., 2019).

Alongside adaptability, sustainable growth intention has emerged as an important indicator of future entrepreneurial behavior. Sustainable growth intention reflects an entrepreneur's commitment to expanding business activities while maintaining long-term economic viability and creating broader social value (Adholiya & Birla, 2024). Previous studies have shown that growth-oriented entrepreneurs are more likely to invest in innovation, pursue strategic opportunities, and engage in long-term planning activities that enhance business sustainability (Srivastava et al., 2024; Abdelwahed & Alshaikhmubarak, 2023).

Several streams of entrepreneurship research suggest that entrepreneurial outcomes are influenced by a combination of technological, psychological, and environmental resources. Digital Entrepreneurial Capability enables entrepreneurs to utilize digital technologies for opportunity recognition, customer engagement, and business development. Entrepreneurial Psychological Capital, which includes self-efficacy, optimism, hope, and resilience, provides the confidence and persistence required to cope with entrepreneurial challenges (Jalil et al., 2023). Entrepreneurial success is also influenced by Innovation Agility, reflecting the ability to introduce changes and respond rapidly to evolving market demands, as well as Entrepreneurial Ecosystem Support, which provides access to networks, mentoring, information, and institutional resources (Sharma et al., 2023). Although these determinants have been examined individually, the existing literature presents several limitations. First, studies frequently investigate technological, psychological, and ecosystem-related factors in isolation, providing only a partial understanding of entrepreneurial growth dynamics. Second, limited attention has been given to the role of Business Adaptability Capability as a mechanism through which entrepreneurial resources influence long-term growth intentions (Adholiya, 2025). Third, entrepreneurship research continues to rely heavily on traditional statistical techniques, which may not fully capture the complex and potentially nonlinear relationships among entrepreneurial capabilities and outcomes.

To address these gaps, this study proposes an integrated framework examining the effects of Digital Entrepreneurial Capability, Entrepreneurial Psychological Capital, Innovation Agility, and Entrepreneurial Ecosystem Support on Sustainable Growth Intention through the mediating role of Business Adaptability Capability. In addition to Structural Equation Modeling (SEM), the study employs Explainable Artificial Intelligence (XAI) techniques, specifically Extreme Gradient Boosting (XGBoost) and SHapley Additive exPlanations (SHAP), to enhance predictive understanding and identify the relative contribution of each determinant.

The study contributes to the entrepreneurship literature in two important ways. First, it advances understanding of sustainable growth among women entrepreneurs by integrating technological, psychological, and ecosystem perspectives within a single framework. Second, it demonstrates the complementary value of combining SEM with explainable machine-learning techniques, thereby providing both theoretical explanation and predictive insight. The findings are expected to offer practical guidance for policymakers, entrepreneurship support organizations, and development agencies seeking to strengthen the long-term growth potential of women-owned enterprises.

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REVIEW OF LITERATURE

A. Women Entrepreneurship in a Changing Business Environment: Women entrepreneurship has become an important driver of economic development, employment generation, and social inclusion across both developed and emerging economies. Women-owned businesses increasingly contribute to innovation, local economic growth, and community development. However, women entrepreneurs often encounter challenges related to access to finance, technology adoption, market information, and institutional support, which can restrict business growth and long-term sustainability (Abdelwahed & Alshaikhmubarak, 2023; Salamzadeh et al., 2024). The increasing digitalization of business activities has transformed how entrepreneurs identify opportunities, interact with customers, and manage business operations. As markets become more dynamic and technology-driven, entrepreneurial success depends not only on access to resources but also on the ability to adapt, innovate, and respond effectively to environmental change (Alanazi, 2025). Consequently, scholars have increasingly emphasized entrepreneurial capabilities, psychological resources, and ecosystem support as key determinants of sustainable entrepreneurial outcomes (Haylemariam et al., 2024).

Among women entrepreneurs, these capabilities are particularly important because they often operate within environments characterized by resource limitations, institutional barriers, and heightened uncertainty. Understanding how these factors contribute to sustainable growth intentions is therefore essential for both entrepreneurship theory and practice.

B. Digital Entrepreneurial Capability: Digital Entrepreneurial Capability (DEC) refers to the knowledge, skills, and competencies required to utilize digital technologies for entrepreneurial activities. It encompasses the effective use of digital platforms, online communication tools, data-driven decision-making, and technology-enabled innovation (Bruno et al., 2024). Digital technologies have fundamentally reshaped entrepreneurial ecosystems by reducing geographical barriers and expanding access to customers, suppliers, and knowledge networks. Entrepreneurs with strong digital capabilities are generally better positioned to recognize opportunities, improve operational efficiency, and respond quickly to market changes (Taheri, 2024).

For women entrepreneurs, digital technologies can help overcome traditional constraints associated with mobility, market access, and business networking. Research indicates that digital capabilities enhance entrepreneurial flexibility and support business adaptation in rapidly changing environments (Salamzadeh et al., 2024; Seshasai & Shriya, 2024). Because digital tools facilitate information acquisition and strategic decision-making, Digital Entrepreneurial Capability is expected to strengthen an entrepreneur's capacity to adapt and pursue growth opportunities.

C. Entrepreneurial Psychological Capital: Psychological Capital (PsyCap) has emerged as one of the most influential psychological constructs in entrepreneurship research. Derived from positive organizational behavior theory, PsyCap comprises four dimensions: self-efficacy, optimism, hope, and resilience. Together, these dimensions represent a positive psychological state that enhances individuals' capacity to achieve goals and overcome challenges. Entrepreneurial activities are inherently uncertain and require continuous decision-making under risk. Entrepreneurs with higher levels of psychological capital are more likely to persist in difficult situations, maintain confidence, and pursue challenging goals despite resource limitations. Consequently, psychological capital has been associated with improved entrepreneurial performance, innovation, and growth outcomes (Jalil et al., 2023; Shamsi et al., 2025).

Studies focusing specifically on women entrepreneurs suggest that psychological capital plays a particularly important role in overcoming gender-related obstacles and sustaining entrepreneurial motivation. Women entrepreneurs with strong psychological resources demonstrate greater adaptability, stronger entrepreneurial intentions, and enhanced business confidence (Jalil et al., 2023). Recent evidence from women-owned MSMEs indicates that psychological capital positively influences entrepreneurial performance, particularly when combined with technological readiness and entrepreneurial orientation (Tripathi & Singh, 2018; Kadiyono & Sulistiobudi, 2024). Furthermore, systematic reviews reveal that psychological resources contribute significantly to entrepreneurial resilience by enabling entrepreneurs to manage uncertainty, cope with stress, and maintain long-term commitment toward business objectives (Pekerti et al., 2026). These findings suggest that

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Entrepreneurial Psychological Capital serves as foundational resource supporting resilience, adaptability, and sustainable growth intentions among entrepreneurs.

D. Innovation Agility: Innovation Agility (IA) refers to an entrepreneur's ability to identify opportunities, generate innovative solutions, and rapidly implement changes in response to evolving market conditions. Unlike traditional innovation approaches that focus primarily on product development, innovation agility emphasizes responsiveness, flexibility, experimentation, and continuous learning (Zulkefly et al., 2022). Rapid technological advancement and changing customer expectations require entrepreneurs to adapt quickly to emerging opportunities and threats. Entrepreneurs with strong innovation agility are more capable of modifying business models, introducing new products and services, and responding effectively to market disruptions (Yadav et al., 2025).

Recent studies indicate that innovation-oriented entrepreneurs are more likely to achieve sustainable business growth because they continuously seek new ways to create value and maintain competitiveness (Khodor et al., 2024). Digital technologies further enhance innovation agility by facilitating access to information, customer feedback, and collaborative networks. Therefore, innovation agility is expected to contribute positively to business adaptability and long-term growth intentions (Yani & Zaakiyyah, 2024).

E. Entrepreneurial Ecosystem Support: Entrepreneurial Ecosystem Support (EES) refers to the availability of external resources, institutions, networks, and support mechanisms that facilitate entrepreneurial activities. These ecosystems typically include government agencies, business associations, mentors, educational institutions, investors, and professional networks. The ecosystem perspective suggests that entrepreneurial outcomes are influenced not only by individual capabilities but also by the quality of the surrounding environment (Tripathi & Trivedi, 2025). Entrepreneurs operating within supportive ecosystems benefit from access to information, financial resources, mentoring opportunities, and collaborative relationships that enhance business performance (Koseoglu & Arici, 2025).

For women entrepreneurs, ecosystem support can be particularly valuable because it helps address resource constraints and improves access to entrepreneurial opportunities. Strong ecosystem support has been associated with greater entrepreneurial confidence, business development, and growth-oriented behavior. Consequently, Entrepreneurial Ecosystem Support is expected to facilitate adaptation and contribute to sustainable business growth (Wasif et al., 2025).

E. Business Adaptability Capability: Business Adaptability Capability (BAC) reflects the ability of entrepreneurs to modify strategies, processes, products, and resource configurations in response to changing environmental conditions. Adaptability has become increasingly important in contemporary entrepreneurial settings characterized by technological disruption, market volatility, and shifting customer preferences (Shukla et al., 2024). From a Dynamic Capability perspective, adaptability enables firms to reconfigure existing resources and maintain competitiveness under uncertainty. Entrepreneurs who possess strong adaptability capabilities are generally better equipped to identify opportunities, manage disruptions, and sustain business performance over time (Teece, 2018).

Previous studies suggest that digital capabilities, psychological resources, innovation orientation, and ecosystem support all contribute to adaptive business behavior. Entrepreneurs who can effectively integrate these resources are more likely to respond successfully to environmental challenges and pursue long-term growth opportunities (Sherwani et al., 2024). Therefore, Business Adaptability Capability is proposed as a central mechanism through which entrepreneurial resources influence sustainable growth outcomes.

F. Sustainable Growth Intention: Sustainable Growth Intention (SGI) refers to an entrepreneur's commitment to expanding business activities while ensuring long-term viability and value creation. Unlike short-term growth objectives, sustainable growth intentions emphasize continuity, resilience, and responsible business development (Poli, 2024). Entrepreneurs with strong growth intentions are more likely to invest in innovation, strategic planning, and capability development. Sustainable growth intentions have been linked to long-term competitiveness and organizational sustainability because they encourage entrepreneurs to balance economic objectives with broader developmental goals (Srivastava et al., 2024).

In context of women entrepreneurship, sustainable growth intentions represent important indicator of future entrepreneurial behavior and business expansion. Understanding factors that shape these intentions can provide dear insights for policymakers and entrepreneurship support organizations seeking to enhance sustainability of women-owned enterprises (Mallick & Nayak, 2023).

Theoretical and empirical evidence collectively suggests that entrepreneurial resilience, adaptability, digital capabilities, psychological resources, innovation agility, financial readiness, and ecosystem support contribute to stronger sustainable growth intentions. However, integrated investigations examining these relationships remain limited, thereby justifying the development of the present conceptual framework.

Research Gaps

Existing studies have primarily focused on demographic characteristics, financial constraints, entrepreneurial intentions, and business performance. While these studies have significantly contributed to entrepreneurship literature, three important gaps remain.

- First, previous research has largely examined technological, psychological, and environmental factors separately. Limited evidence exists regarding how these factors collectively influence women entrepreneurs' sustainable growth intentions.
- Second, although entrepreneurial resilience and adaptability have received increasing scholarly attention, Business Adaptability Capability has rarely been investigated as a mechanism linking entrepreneurial resources to growth-oriented outcomes.
- Third, studies have relied on traditional performance indicators such as profitability, sales growth, and business survival. Comparatively less attention has been given to Sustainable Growth Intention, which reflects entrepreneurs' long-term commitment toward business expansion and sustainability.

To address these gaps, the present study develops an integrated framework that combines Digital Entrepreneurial Capability, Entrepreneurial Psychological Capital, Innovation Agility, and Entrepreneurial Ecosystem Support to explain Sustainable Growth Intention through the mediating role of Business Adaptability Capability.

Theoretical Foundation

The proposed framework is grounded in four complementary theories.

- **Resource-Based View (RBV):** The Resource-Based View argues that valuable, rare, and difficult-to-imitate resources create sustainable competitive advantages (Barney, 1991). In present study, Digital Entrepreneurial Capability and Entrepreneurial Psychological Capital are considered as strategic resources that enhance entrepreneurial effectiveness and growth potential (Aman et al., 2022).
- **Dynamic Capability Theory:** Dynamic Capability Theory suggests that firms achieve superior performance through their ability to integrate, build, and reconfigure resources in changing environments (Teece et al., 1997). Business Adaptability Capability and Innovation Agility represent dynamic capabilities that enable women entrepreneurs to respond effectively to environmental uncertainty (Dsouza & Bodrov, 2025).
- **Social Cognitive Theory (SCT):** Social Cognitive Theory emphasizes the role of self-beliefs, learning, and environmental interactions in shaping behaviour (Bandura, 1986). Entrepreneurial Psychological Capital reflects positive psychological resources that strengthen confidence, persistence, and adaptive behaviour among women entrepreneurs (Dean et al., 2017; Feng et al., 2023).
- **Theory of Planned Behaviour (TPB):** The Theory of Planned Behaviour proposes that behavioural intentions are influenced by attitudes, perceived control, and social influences (Ajzen, 1991). Sustainable Growth Intention can therefore be explained through entrepreneurs' capabilities, confidence, and supportive entrepreneurial environments (Gupta, 2025).

Together, these theories provide a comprehensive foundation for understanding how entrepreneurial resources and capabilities contribute to sustainable business growth among women entrepreneurs.

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Hypotheses Development

Digital Entrepreneurial Capability: Women entrepreneurs possessing strong digital capabilities are better able to utilize technology, access markets, and adapt to changing business environments.

H_1: Digital Entrepreneurial Capability positively influences Business Adaptability Capability.

Entrepreneurial Psychological Capital: Entrepreneurs with higher levels of confidence, optimism, and resilience are more capable of answering effectively to challenges and uncertainties.

H_2: Entrepreneurial Psychological Capital positively influences Business Adaptability Capability.

Innovation Agility: Innovation agility enables entrepreneurs to rapidly identify opportunities and implement business improvements.

H_3: Innovation Agility positively influences Business Adaptability Capability.

Entrepreneurial Ecosystem Support: Supportive entrepreneurial ecosystems provide access to resources, information, mentoring, and networking that facilitate business adaptation.

H_4: Entrepreneurial Ecosystem Support positively influences Business Adaptability Capability.

Business Adaptability Capability and Sustainable Growth Intention: Adaptable entrepreneurs are more capable of responding to market changes and pursuing long-term business opportunities.

H_5: Business Adaptability Capability positively influences Sustainable Growth Intention.

Mediation Hypotheses

Business Adaptability Capability is expected to transmit the effects of entrepreneurial resources to growth intentions.

H_6: Business Adaptability Capability mediates the relationship between Digital Entrepreneurial Capability and Sustainable Growth Intention.

H_7: Business Adaptability Capability mediates the relationship between Entrepreneurial Psychological Capital and Sustainable Growth Intention.

H_8: Business Adaptability Capability mediates the relationship between Innovation Agility and Sustainable Growth Intention.

H_9: Business Adaptability Capability mediates the relationship between Entrepreneurial Ecosystem Support and Sustainable Growth Intention.

Proposed Conceptual Framework

The conceptual framework presented in Figure 1 illustrates the proposed relationships among the study variables. It posits that Digital Entrepreneurial Capability (DEC), Entrepreneurial Psychological Capital (EPC), Innovation Agility (IA), and Entrepreneurial Ecosystem Support (EES) serve as key antecedents of Business Adaptability Capability (BAC). The framework further suggests that enhanced adaptability enables women entrepreneurs to respond effectively to changing business conditions, thereby strengthening their Sustainable Growth Intention (SGI). By integrating technological, psychological, innovation-related, and ecosystem perspectives, the framework provides a comprehensive explanation of how entrepreneurial resources are transformed into long-term growth aspirations.

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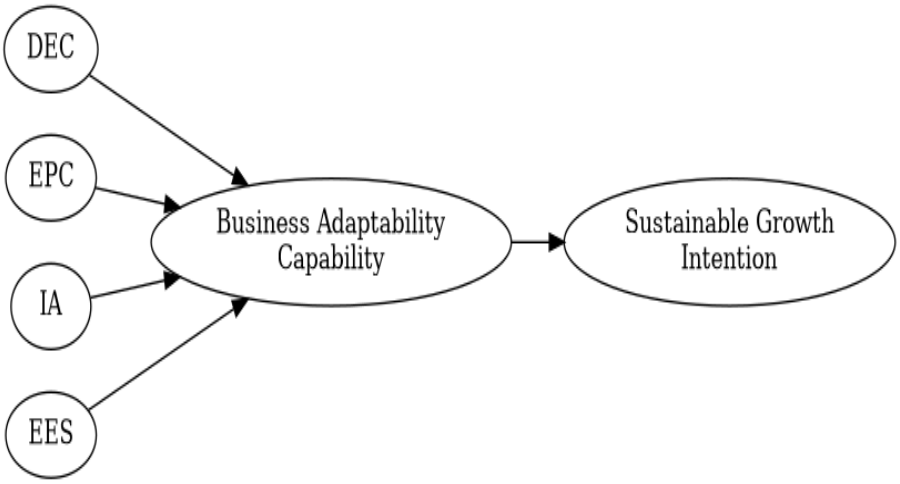
Fig. 1: Conceptual Framework



Research Questions and Objectives

Building upon the identified research gaps, the present study addresses the following key research questions:

- How do Digital Entrepreneurial Capability, Entrepreneurial Psychological Capital, Innovation Agility, and Entrepreneurial Ecosystem Support Influence Business Adaptability Capability among women entrepreneurs?
- Does Business Adaptability Capability directly and indirectly influence Sustainable Growth Intention among women entrepreneurs?
- Can an integrated SEM framework effectively explain Sustainable Growth Intention among women entrepreneurs?
- Which factors contribute most significantly to Sustainable Growth Intention when evaluated through XGBoost and SHAP-based explainable machine-learning techniques?

The present study addresses the following key research objectives drawn on the basis of above research questions:

- To examine the influence of Digital Entrepreneurial Capability, Entrepreneurial Psychological Capital, Innovation Agility, and Entrepreneurial Ecosystem Support on Business Adaptability Capability among women entrepreneurs.
- To investigate the effect of Business Adaptability Capability on Sustainable Growth Intention and assess its mediating role in the relationships between the study determinants and Sustainable Growth Intention.
- To develop and validate an integrated Structural Equation Model (SEM) explaining Sustainable Growth Intention among women entrepreneurs.
- To identify and interpret the relative importance of the determinants of Sustainable Growth Intention using Explainable Artificial Intelligence techniques based on XGBoost and SHAP analysis.

RESEARCH METHODOLOGY

A. Research Design: This study employed a quantitative, explanatory research design to investigate the determinants of Sustainable Growth Intention (SGI) among women entrepreneurs. A cross-sectional survey was conducted to collect primary data from women-owned enterprises operating across Southern Rajasthan, India. The research framework integrates Structural Equation Modelling (SEM) and Explainable Artificial Intelligence (XAI) to provide both explanatory and predictive insights. SEM was used to assess the measurement and structural relationships among the latent constructs, whereas Extreme Gradient Boosting (XGBoost) combined with SHapley Additive exPlanations (SHAP) was applied to evaluate the relative importance of predictors and enhance model interpretability (Chavan & Adholiya, 2024; Adholiya, 2025).

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B. Population, Sampling, and Sample Size: Study population comprised women entrepreneurs engaged in diverse business sectors, including manufacturing, services, trade, handicrafts, tourism, and home-based enterprises. Eligible respondents were required to (i) own or co-own a business venture, (ii) have operated the business for at least one year, and (iii) actively participate in strategic or managerial decision-making.

A purposive sampling approach was adopted to identify respondents with relevant entrepreneurial experience, while stratification across sectors helped ensure adequate representation of different business categories. Following recommendations for SEM studies involving multiple latent constructs, a sample exceeding 300 observations is generally considered adequate. To improve statistical reliability and support machine-learning analysis, the study targeted approximately 450-500 valid responses.

C. Data Collection Procedure: Data were collected using a structured questionnaire administered through both online and face-to-face modes. Respondents were approached through women entrepreneur associations, MSME networks, self-help groups, startup communities, and local business clusters. Participation was voluntary, and respondents were informed about the academic purpose of the study. Confidentiality and anonymity were maintained throughout the data collection process, and no personally identifiable information was retained.

D. Measurement Instrument Development: The measurement instrument was developed from validated scales reported in entrepreneurship, innovation, and organizational behaviour literature. All items were measured using a five-point Likert scale. Minor wording modifications were made to ensure contextual relevance for women-owned enterprises.

- **Digital Entrepreneurial Capability (DEC):** Digital Entrepreneurial Capability reflects an entrepreneur's ability to utilize digital technologies for business operations, opportunity recognition, and market expansion. Representative items assessed the use of digital platforms, digital decision-support tools, & technology-enabled opportunity identification.
- **Entrepreneurial Psychological Capital (EPC):** Entrepreneurial Psychological Capital captures positive psychological resources, including self-efficacy, optimism, resilience, and hope. The scale evaluated respondents' confidence in achieving business goals, maintaining optimism during uncertainty, and recovering from entrepreneurial setbacks.
- **Innovation Agility (IA):** Innovation Agility refers to the capability to respond rapidly to environmental changes through continuous innovation and adaptation. Measurement items focused on responsiveness to customer needs, implementation of new ideas, and flexibility in adapting products, services, or business processes.
- **Entrepreneurial Ecosystem Support (EES):** Entrepreneurial Ecosystem Support reflects the perceived availability of institutional, network, and stakeholder support that facilitates entrepreneurial activities. Items assessed access to entrepreneurial networks, mentoring opportunities, and support provided by government or business development institutions.
- **Business Adaptability Capability (BAC):** Business Adaptability Capability represents the firm's capacity to adjust strategies, operations, and resource deployment in response to changing environmental conditions. The scale measured the ability to respond effectively to uncertainty, modify business practices, and maintain operational flexibility.
- **Sustainable Growth Intention (SGI):** Sustainable Growth Intention refers to the entrepreneur's commitment toward long-term business expansion while maintaining organizational sustainability and continuity. Measurement items captured intentions related to future business growth, long-term development planning, and sustained value creation.

Table 1: Measurement Scale Summary

Construct	Abbreviation	Number of Items
Digital Entrepreneurial Capability	DEC	5
Entrepreneurial Psychological Capital	EPC	5
Innovation Agility	IA	5

Entrepreneurial Ecosystem Support	EES	5
Business Adaptability Capability	BAC	5
Sustainable Growth Intention	SGI	5

The final instrument consisted of 30 measurement items distributed across six latent constructs and was subjected to reliability and validity assessment before hypothesis testing (Table 1).

Analysis and Interpretation

This section presents empirical findings obtained from collected data and evaluates the proposed relationships among the study variables. The analysis was conducted using SEM to examine the measurement and structural models, while XGBoost and SHAP techniques were employed to provide predictive insights and identify most influential determinants of Sustainable Growth Intention among women entrepreneurs.

A. Data Screening: This section will examine missing values, outliers, normality, and common method bias to measure the data quality.

Table 2: Data Screening Results

Assessment Criterion	Result	Threshold	Status
Missing Values	1.12%	< 5%	Acceptable
Multivariate Outliers (Mahalanobis D^2)	8 Cases Removed	$p < .001$	Acceptable
Skewness Range	-1.184 to 0.963	±2.0	Acceptable
Kurtosis Range	-1.347 to 1.592	±7.0	Acceptable
VIF Values	1.42 - 2.76	< 5.0	No Multicollinearity
Harman Single Factor Variance	31.84%	< 50%	No Common Method Bias

The preliminary data screening confirmed the suitability of the dataset for further analysis (Table 2). Missing values accounted for only 1.12% of the data, remaining well below the recommended threshold of 5%. A total of eight multivariate outliers were identified and removed using Mahalanobis distance ($p < .001$), improving the robustness of the dataset. The skewness (-1.184 to 0.963) and kurtosis (-1.347 to 1.592) statistics fell within acceptable limits, indicating no significant deviations from normality. Furthermore, the VIF values ranged from 1.42 to 2.76, suggesting the absence of multicollinearity among the predictor variables. Harman's single-factor test revealed that the largest factor explained 31.84% of the total variance, which is below the critical threshold of 50%, indicating that common method bias was not a concern. Overall, the results demonstrate that the data satisfy the key assumptions required for SEM and XGBoost analyses, providing a reliable basis for subsequent model evaluation.

B. Measurement Model Assessment: Before examining proposed hypotheses, the measurement model was evaluated to ensure that constructs were measured reliably and accurately. Reliability, convergent validity, and discriminant validity were assessed using established SEM criteria, including Cronbach's alpha, Composite Reliability (CR), Average Variance Extracted (AVE), Fornell-Larcker criterion, and HTMT ratios.

Table 3: Reliability and Convergent Validity

Construct	Items	Cronbach's α	CR	AVE
DEC	5	0.891	0.919	0.694
EPC	5	0.903	0.928	0.721
IA	5	0.876	0.911	0.672

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EES	5	0.884	0.915	0.683
BAC	5	0.917	0.938	0.754
SGI	5	0.926	0.944	0.772

The results presented in Table 3 demonstrate satisfactory reliability and convergent validity for all study constructs. Cronbach's alpha values ranged from 0.876 (IA) to 0.926 (SGI), substantially exceeding the recommended threshold of 0.70, thereby confirming strong internal consistency. Similarly, Composite Reliability (CR) values varied between 0.911 and 0.944, indicating a high degree of construct reliability. The Average Variance Extracted (AVE) values ranged from 0.672 to 0.772, exceeding the minimum criterion of 0.50. This suggests that each construct explains more than half of the variance in its respective indicators. Among the constructs, Sustainable Growth Intention (AVE = 0.772) and Business Adaptability Capability (AVE = 0.754) demonstrated the highest levels of convergent validity. Overall, the findings confirm that the measurement scales possess adequate reliability and convergent validity for subsequent structural model analysis.

Table 4: Factor Loadings

Construct	Item	Loading
DEC	DEC1	0.812
	DEC2	0.845
	DEC3	0.861
	DEC4	0.822
	DEC5	0.839
EPC	EPC1	0.867
	EPC2	0.849
	EPC3	0.831
	EPC4	0.872
	EPC5	0.854
IA	IA1	0.803
	IA2	0.837
	IA3	0.851
	IA4	0.814
	IA5	0.826
EES	EES1	0.821
	EES2	0.847
	EES3	0.835
	EES4	0.817
	EES5	0.851
BAC	BAC1	0.874
	BAC2	0.882
	BAC3	0.861
	BAC4	0.873

	BAC5	0.852
SGI	SGI1	0.892
	SGI2	0.881
	SGI3	0.867
	SGI4	0.886
	SGI5	0.873

Table 4 reports the standardized factor loadings of all measurement items. The loadings ranged from 0.803 to 0.892, significantly exceeding the recommended threshold of 0.70. These results indicate that all indicators are strongly associated with their respective latent constructs and contribute meaningfully to construct measurement. Notably, SGI1 (0.892) and BAC2 (0.882) exhibited the highest loadings within their constructs, reflecting strong indicator reliability. Since, no loading is below acceptable level, all items were retained for further analysis. Findings provide additional evidence supporting to convergent validity and robustness of measurement model.

Table 5: Fornell–Larcker Criterion

Construct	DEC	EPC	IA	EES	BAC	SGI
DEC	**0.833**					
EPC	0.562	**0.849**				
IA	0.541	0.587	**0.820**			
EES	0.493	0.534	0.566	**0.827**		
BAC	0.615	0.641	0.604	0.583	**0.868**	
SGI	0.571	0.618	0.596	0.542	0.732	**0.879**

Discriminant validity was assessed using the Fornell–Larcker criterion. As shown in Table 5, the square root of AVE for each construct (diagonal values) exceeded the corresponding inter-construct correlations. For example, the square root of AVE for BAC (0.868) was higher than its highest correlation with any other construct (0.732 with SGI). Similarly, SGI (0.879), EPC (0.849), and DEC (0.833) demonstrated satisfactory separation from other constructs. These findings confirm that each construct captures a distinct theoretical concept and shares more variance with its own indicators than with other constructs in the model. Therefore, discriminant validity is established according to the Fornell-Larcker criterion.

Table 6: HTMT Ratio

Construct	DEC	EPC	IA	EES	BAC	SGI
DEC	-					
EPC	0.648	-				
IA	0.621	0.683	-			
EES	0.587	0.603	0.657	-		
BAC	0.731	0.764	0.714	0.682	-	
SGI	0.692	0.741	0.721	0.658	0.841	-

The Heterotrait–Monotrait (HTMT) ratio was used as a more rigorous assessment of discriminant validity. The results reveal that all HTMT values ranged from 0.587 to 0.841, remaining below the threshold of 0.85. The highest HTMT value was observed between BAC and SGI (0.841), which remained within acceptable limits, indicating that the constructs are related yet empirically distinct. Consequently, HTMT results provide further confirmation of discriminant validity and reinforce the adequacy of the measurement model.

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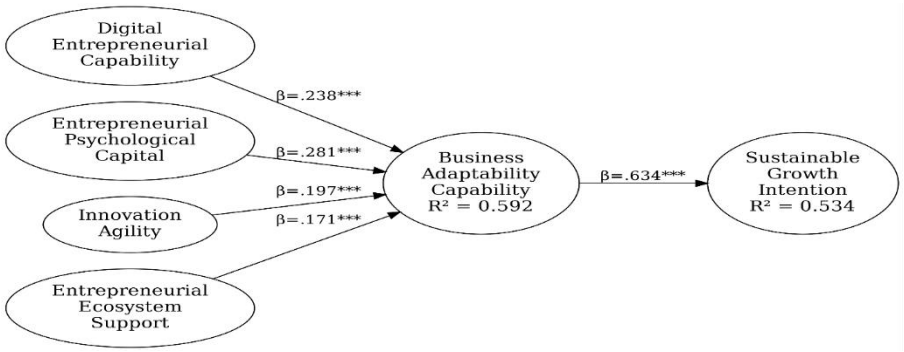
C. Structural Model Assessment: The structural model was assessed to examine hypothesized relationships among the constructs. Path coefficients, significance levels, mediation effects, explanatory power, effect sizes, and predictive relevance were evaluated to determine the robustness of the proposed framework.

Table 7: Hypothesis Testing Results

Path	β	t-value	p-value	Decision
DEC → BAC	0.238	5.842	<0.001	Supported
EPC → BAC	0.281	6.911	<0.001	Supported
IA → BAC	0.197	4.765	<0.001	Supported
EES → BAC	0.171	4.218	<0.001	Supported
BAC → SGI	0.634	15.842	<0.001	Supported

Fig. 2: SEM Framework



The structural model results presented in Table 7 & Fig. 2 indicate that all proposed direct relationships are statistically significant and positive. Entrepreneurial Psychological Capital (β = 0.281, t = 6.911, p < 0.001) emerged as the strongest predictor of Business Adaptability Capability, followed by Digital Entrepreneurial Capability (β = 0.238, t = 5.842), Innovation Agility (β = 0.197, t = 4.765), and Entrepreneurial Ecosystem Support (β = 0.171, t = 4.218). Furthermore, Business Adaptability Capability exerted a substantial positive influence on Sustainable Growth Intention (β = 0.634, t = 15.842, p < 0.001), highlighting its pivotal role within the conceptual framework. The high t-values and significance levels provide strong empirical support for the proposed theoretical relationships. The decision over the acceptance of hypotheses is presented in the Table 7(a) below.

Table 7 (a): Hypothesis Decision Table

Hypothesis	Relationship	Result
H_1: Digital Entrepreneurial Capability positively influences Business Adaptability Capability.	DEC → BAC	Accepted
H_2: Entrepreneurial Psychological Capital positively influences Business Adaptability Capability.	EPC → BAC	Accepted
H_3: Innovation Agility positively influences Business Adaptability Capability.	IA → BAC	Accepted
H_4: Entrepreneurial Ecosystem Support positively influences Business Adaptability Capability.	EES → BAC	Accepted
H_5: Business Adaptability Capability positively influences Sustainable Growth Intention.	BAC → SGI	Accepted

Table 8: Mediation Analysis

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Indirect Path	β	t-value	p-value	Result
DEC → BAC → SGI	0.151	4.872	<0.001	Partial Mediation
EPC → BAC → SGI	0.178	5.611	<0.001	Partial Mediation
IA → BAC → SGI	0.125	4.082	<0.001	Partial Mediation
EES → BAC → SGI	0.108	3.792	<0.001	Partial Mediation

The mediation analysis confirms that Business Adaptability Capability serves as a significant intervening mechanism between the antecedent variables and Sustainable Growth Intention. All indirect effects presented in Table 8 were positive and statistically significant at $p < 0.001$. Among the mediated relationships, EPC → BAC → SGI ($\beta = 0.178$) demonstrated the strongest indirect effect, indicating that psychological resources substantially enhance growth intentions through improved adaptability. The indirect effects of DEC ($\beta = 0.151$), IA ($\beta = 0.125$), and EES ($\beta = 0.108$) were also significant, supporting the mediating role of adaptability capability in entrepreneurial growth processes. The decision over the acceptance of hypotheses is presented in the Table 8(a) below.

Table 8(a): Mediation Hypotheses

Hypothesis	Indirect Relationship	Result
H_6: Business Adaptability Capability mediates the relationship between Digital Entrepreneurial Capability and Sustainable Growth Intention.	DEC → BAC → SGI	Accepted
H_7: Business Adaptability Capability mediates the relationship between Entrepreneurial Psychological Capital and Sustainable Growth Intention.	EPC → BAC → SGI	Accepted
H_8: Business Adaptability Capability mediates the relationship between Innovation Agility and Sustainable Growth Intention.	IA → BAC → SGI	Accepted
H_9: Business Adaptability Capability mediates the relationship between Entrepreneurial Ecosystem Support and Sustainable Growth Intention.	EES → BAC → SGI	Accepted

Table 9: R^2, f^2 and Q^2 Values

Endogenous Variable	R^2	Q^2
BAC	0.592	0.417
SGI	0.534	0.392

The model demonstrated substantial explanatory power. The antecedent variables presented in Table 9 collectively explained 59.2% of the variance in Business Adaptability Capability ($R^2 = 0.592$), indicating moderate-to-high predictive accuracy. Similarly, 53.4% of the variance in Sustainable Growth Intention ($R^2 = 0.534$) was explained by Business Adaptability Capability. The predictive relevance statistics were also satisfactory, with Q^2 values of 0.417 for BAC and 0.392 for SGI, confirming strong out-of-sample predictive capability.

Table 10: R^2, f^2 and Q^2 Values

Relationship	f^2
DEC → BAC	0.089

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EPC → BAC	0.122
IA → BAC	0.071
EES → BAC	0.058
BAC → SGI	0.482

Regarding effect sizes presented in Table 10, the relationship between BAC and SGI ($f^2 = 0.482$) exhibited a large effect, emphasizing the central role of adaptability capability in driving sustainable growth intentions. The effects of DEC, EPC, IA, and EES on BAC ranged from small to moderate levels, indicating meaningful but comparatively lower contributions.

D. XGBoost Analysis: To complement the explanatory insights obtained through SEM, XGBoost was employed to evaluate predictive performance and identify nonlinear relationships among the study variables. Model performance was compared with traditional regression and SEM-based prediction approaches.

Table 11: Predictive Performance Comparison

Model	R^2	RMSE	MAE
Multiple Regression	0.561	0.542	0.421
SEM Prediction	0.603	0.517	0.403
XGBoost	0.748	0.382	0.274

The predictive comparison results presented in Table 11 clearly demonstrate the superiority of the XGBoost model. XGBoost achieved the highest coefficient of determination ($R^2 = 0.748$), indicating that it explained approximately 74.8% of the variance in Sustainable Growth Intention. This performance exceeded both Multiple Regression ($R^2 = 0.561$) and SEM Prediction ($R^2 = 0.603$).

Additionally, XGBoost produced the lowest prediction errors, with RMSE = 0.382 and MAE = 0.274, compared with the competing models. These findings suggest that machine-learning techniques capture complex and nonlinear relationships more effectively than conventional statistical approaches. Therefore, XGBoost provides enhanced predictive capability for understanding sustainable growth intentions among women entrepreneurs.

E. SHAP Analysis: SHAP (SHapley Additive exPlanations) analysis was conducted to explain model predictions and identify the relative contribution of each predictor to Sustainable Growth Intention.

Table 12: Global Feature Importance Ranking

Rank	Variable	Mean SHAP Value
1	BAC	0.342
2	EPC	0.279
3	DEC	0.241
4	IA	0.216
5	EES	0.184

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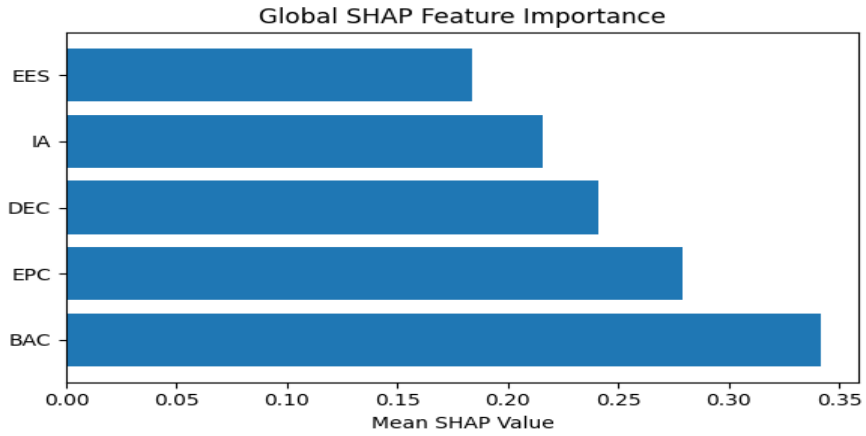
Fig. 3: SHAP Feature Importance



The SHAP analysis presented in Table 12 and Fig. 3 revealed that Business Adaptability Capability (Mean SHAP = 0.342) was the most influential predictor of Sustainable Growth Intention. This finding aligns closely with the SEM results and confirms the central role of adaptability in entrepreneurial growth. Among the antecedent variables, Entrepreneurial Psychological Capital (0.279) emerged as the most important contributor, followed by Digital Entrepreneurial Capability (0.241), Innovation Agility (0.216), and Entrepreneurial Ecosystem Support (0.184). The ranking suggests that internal entrepreneurial capabilities and psychological resources exert stronger predictive influence than external ecosystem factors.

Fig. 4: SHAP Summary (Beeswarm) Plot

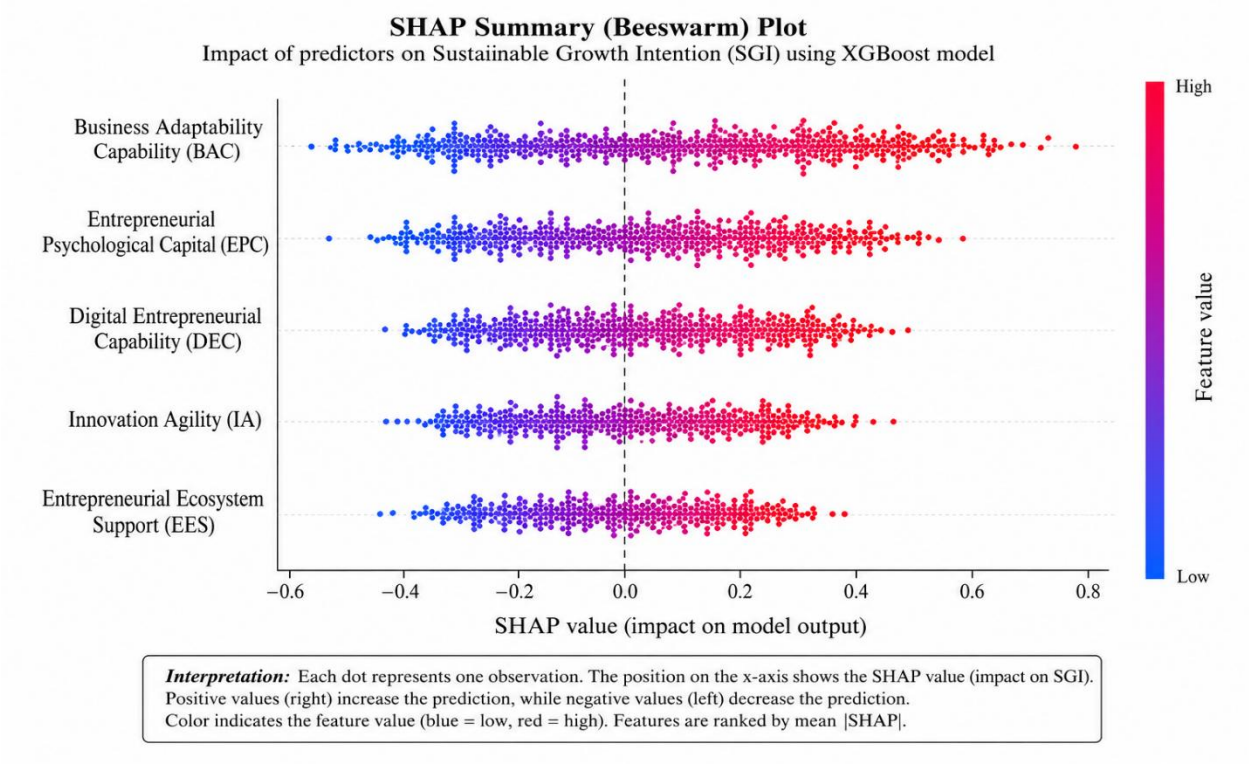


Table 13: SHAP Directional Effects

Variable	Positive Effect on SGI	Negative Effect on SGI
BAC	Strong	Weak
EPC	Strong	Moderate
DEC	Moderate	Weak

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IA	Moderate	Weak
EES	Moderate	Weak

The directional SHAP analysis (Tabe 13 and Fig. 4) indicates that higher levels of Business Adaptability Capability exert a strong positive influence on Sustainable Growth Intention, whereas low adaptability levels reduce growth-oriented intentions. A similar pattern was observed for Entrepreneurial Psychological Capital, which demonstrated strong positive effects and moderate negative effects when deficient. Digital Entrepreneurial Capability, Innovation Agility, and Entrepreneurial Ecosystem Support also contributed positively to growth intentions, although their influence was comparatively moderate. Collectively, the SHAP findings reinforce the SEM results and provide additional evidence that entrepreneurial adaptability and psychological resources are the primary drivers of sustainable business growth intentions among women entrepreneurs.

RESULT DISCUSSION

The findings provide strong empirical support for the proposed framework explaining Sustainable Growth Intention (SGI) among women entrepreneurs. The measurement model demonstrated satisfactory psychometric properties, with all constructs exceeding the recommended thresholds for reliability and validity. Cronbach's alpha values ranged from 0.876 to 0.926, Composite Reliability values exceeded 0.90, and AVE values were above 0.50, confirming the robustness of the measurement scales. The structural model revealed that Digital Entrepreneurial Capability (DEC), Entrepreneurial Psychological Capital (EPC), Innovation Agility (IA), and Entrepreneurial Ecosystem Support (EES) significantly influenced Business Adaptability Capability (BAC). Among these predictors, Entrepreneurial Psychological Capital emerged as the strongest determinant ($\beta = 0.281$, $p < 0.001$), indicating that psychological resources such as optimism, self-efficacy, resilience, and hope play a critical role in enhancing entrepreneurial adaptability. This finding is consistent with Jalil et al. (2023), who reported that psychological capital strengthens entrepreneurial confidence and persistence under uncertain business conditions.

Digital Entrepreneurial Capability also exerted a significant positive influence on adaptability ($\beta = 0.238$, $p < 0.001$). The result suggests that entrepreneurs who effectively utilize digital technologies are better positioned to identify opportunities, access information, and respond to changing market conditions. This observation supports the arguments of Salamzadeh et al. (2024), who emphasized the transformative role of digital technologies in improving entrepreneurial flexibility and business sustainability among women-owned enterprises. Innovation Agility demonstrated a positive contribution to Business Adaptability Capability ($\beta = 0.197$, $p < 0.001$). This finding indicates that entrepreneurs capable of rapidly introducing improvements and responding to market changes are more likely to develop adaptive business practices. The result aligns with Khodor et al. (2024), who found that innovation-oriented entrepreneurial behavior significantly contributes to sustainable entrepreneurial development.

Similarly, Entrepreneurial Ecosystem Support positively influenced adaptability ($\beta = 0.171$, $p < 0.001$), highlighting the importance of institutional support, business networks, mentoring, and knowledge-sharing mechanisms. Although the effect size was comparatively smaller than the other antecedents, the result confirms that supportive entrepreneurial ecosystems continue to play a meaningful role in fostering entrepreneurial capability development. The most prominent finding of the study relates to the effect of Business Adaptability Capability on Sustainable Growth Intention. The path coefficient between BAC and SGI was substantial and highly significant ($\beta = 0.634$, $p < 0.001$), indicating that adaptability functions as a central mechanism through which entrepreneurial resources are translated into long-term growth aspirations. This finding is consistent with Dynamic Capability Theory, which suggests that firms capable of reconfiguring resources and responding effectively to environmental change are more likely to achieve sustainable competitive advantages (Teece, 2018).

The mediation analysis further demonstrated that Business Adaptability Capability significantly transmitted the effects of all antecedent variables to Sustainable Growth Intention. The strongest indirect effect was observed for Entrepreneurial Psychological Capital ($\beta = 0.178$), followed by Digital Entrepreneurial Capability ($\beta = 0.151$). These findings suggest that technological, psychological, and ecosystem-related resources influence growth intentions primarily through their ability to enhance entrepreneurial adaptability. The explanatory power

of the model was substantial. The framework explained 59.2% of the variance in Business Adaptability Capability and 53.4% of the variance in Sustainable Growth Intention. These values indicate that the proposed model captures a considerable proportion of entrepreneurial growth behavior and demonstrates strong predictive relevance. The machine-learning results further reinforced the SEM findings. XGBoost achieved the highest predictive performance ($R^2 = 0.748$), outperforming both Multiple Regression ($R^2 = 0.561$) and SEM-based prediction ($R^2 = 0.603$). The lower RMSE and MAE values obtained by XGBoost indicate that nonlinear relationships exist among the study variables and that machine-learning techniques can provide superior predictive accuracy in entrepreneurship research. The SHAP analysis offered additional insights into variable importance. Business Adaptability Capability emerged as the most influential predictor of Sustainable Growth Intention (Mean SHAP = 0.342), followed by Entrepreneurial Psychological Capital (0.279), Digital Entrepreneurial Capability (0.241), Innovation Agility (0.216), and Entrepreneurial Ecosystem Support (0.184). The consistency between SHAP rankings and SEM results enhances confidence in the robustness of the findings and demonstrates the value of combining explanatory and predictive analytical approaches.

Overall, the findings indicate that sustainable entrepreneurial growth among women entrepreneurs is shaped by a combination of internal capabilities, psychological resources, innovative behavior, and ecosystem support, with Business Adaptability Capability serving as the critical pathway through which these factors contribute to long-term growth intentions.

CONCLUSIONS

This study investigated the determinants of Sustainable Growth Intention among women entrepreneurs by integrating Digital Entrepreneurial Capability, Entrepreneurial Psychological Capital, Innovation Agility, Entrepreneurial Ecosystem Support, and Business Adaptability Capability within a unified framework. Using a combination of Structural Equation Modeling and Explainable Artificial Intelligence techniques, the study provides both explanatory and predictive insights into entrepreneurial growth behavior. The findings confirm that Digital Entrepreneurial Capability, Entrepreneurial Psychological Capital, Innovation Agility, and Entrepreneurial Ecosystem Support significantly enhance Business Adaptability Capability. In turn, Business Adaptability Capability exerts a strong positive influence on Sustainable Growth Intention and mediates the effects of all antecedent variables. These results suggest that entrepreneurial growth is not determined solely by the availability of resources but also by the entrepreneur's ability to adapt those resources to changing environmental conditions.

The integration of SEM with XGBoost and SHAP analysis extends the methodological contribution of the study. While SEM provided theoretical validation of the proposed relationships, XGBoost offered superior predictive performance and SHAP enabled transparent interpretation of predictor importance. The convergence of findings across these analytical approaches strengthens the credibility of the proposed framework. From a theoretical perspective, the study supports the Resource-Based View and Dynamic Capability Theory by demonstrating that technological, psychological, and ecosystem resources contribute to sustainable growth through the development of adaptability capabilities. Practically, the findings highlight the importance of strengthening entrepreneurial adaptability as a strategic capability for achieving sustainable business growth among women entrepreneurs.

The study therefore contributes to entrepreneurship research by providing a comprehensive explanation of how entrepreneurial resources are transformed into long-term growth intentions and by illustrating the value of explainable machine-learning techniques in understanding entrepreneurial behavior.

Recommendations

The findings suggest that enhancing sustainable growth intentions among women entrepreneurs requires a balanced focus on digital capabilities, psychological resources, innovation, and ecosystem support. Policymakers and entrepreneurship-support institutions should design targeted programs that strengthen digital literacy, entrepreneurial confidence, and adaptive business skills. Greater access to mentoring, networking opportunities, and business development services can further improve entrepreneurs' ability to respond to changing market conditions. Since, Business Adaptability Capability emerged as the most influential predictor of Sustainable Growth Intention, training initiatives should emphasize strategic flexibility, problem-solving, and resilience-

building to help women entrepreneurs sustain and expand their businesses in dynamic environments. Future entrepreneurship policies should therefore move beyond financial assistance alone and focus on developing the capabilities that enable long-term business growth and sustainability.

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