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Digital Literacy for Business Performance: A Study of Entrepreneurs

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Abstract

This study investigates the relationship between digital literacy levels among entrepreneurs and their impact on business performance. Specifically, it examines how entrepreneurs' digital skills significantly influence financial and marketing efficiency. The study evaluates the effects of digital literacy on business performance within the theoretical frameworks of the Digital Economy (DE), Digital Orientation (DO), Dynamic Capabilities (DC), and Adaptive Capability (AC). Using a quantitative approach and structural equation modeling (SEM), a novel analytical framework was developed on the basis of data collected from 354 members of provincial chambers of commerce across Thailand. The findings reveal that digital literacy positively and significantly impacts both financial and marketing performance, with adaptive capability serving as the most influential indirect factor. These results emphasize the critical importance of fostering digital skills among entrepreneurs to enhance innovation, adaptability, and sustainable growth in a competitive digital economy. This study contributes to the expanding literature on digital transformation by providing actionable insights into the practical applications of digital literacy for entrepreneurial success. Policymakers and business leaders are encouraged to prioritize the development of digital skills as a strategic pillar for achieving growth and competitiveness in the digital era.

Keywords: Digital Literacy; Thai Entrepreneurs; Performance; Structural Equation Modeling.

1. Introduction

The digital revolution has fundamentally reshaped the global landscape, making digital literacy not just an advantage but also a necessity. Individuals and organizations alike must possess a diverse range of competencies to thrive in this new era. These "digital skills," as they are often called [1, 2], encompass the technical know-how, conceptual understanding, and social aptitudes required to effectively navigate and solve problems in digital environments. They are, without question, a core-learning requirement for citizens of the 21st century [3]. Nowhere is this truer than in the entrepreneurial world. For those seeking to build and grow businesses, strong digital literacy is inextricably linked to enhanced performance and competitive strength. Entrepreneurs today must be digitally savvy; they must be able to adapt to technological change and competitive pressures with agility and vision [4].

While existing research offers valuable insights into digital skills across various demographics and sectors [5, 6], there remains a significant gap in the understanding of the specific components and metrics of digital literacy among entrepreneurs. This is surprising, given the widely acknowledged importance of these skills for both entrepreneurial success and long-term business sustainability [7]. We simply cannot afford to make assumptions about what constitutes digital competence for those who are driving innovation and economic growth.

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The rise of the digital economy has profoundly altered the way we conduct business. Transactions are increasingly dependent on a complex and interconnected ecosystem of digital technologies, such as cloud computing, sophisticated software platforms, and high-speed communication networks [8]. This trend, which is already significant, has been further amplified by global events such as the COVID-19 pandemic, which accelerated the adoption of digital solutions across industries [9, 10]. Looking forward, projections from the World Economic Forum suggest that approximately 70% of the global GDP will be digitally driven by 2030 [11]. This underscores the critical importance of digital fluency for any enterprise hoping to remain competitive [12]. In fact, organizations with digitally skilled workforces are increasingly becoming leaders in their respective fields [13]. Surveys indicate that many businesses now view digital workforce strategies as essential for success.

Recent studies have highlighted the significant role of digital literacy in enhancing entrepreneurial performance. For instance, Mohamad et al. (2025) [14] reported that digital literacy and entrepreneurial competencies significantly impact digital entrepreneurship, with entrepreneurial competencies having a stronger influence. The study also noted that while government support alone does not directly affect digital entrepreneurship, its combination with digital literacy does enhance entrepreneurial outcomes. Similarly, Raharjo et al. (2024) [15] examined the impact of digital literacy on digital transformation, exploring the antecedent factors shaping digital literacy. These findings underscore the necessity for entrepreneurs to develop robust digital skills to navigate the evolving digital landscape effectively. Small and medium-sized enterprises (SMEs), particularly within the European Union, provide compelling examples. For many of these businesses, digital sales channels, including e-commerce and social media platforms, have become key drivers of revenue growth, especially in the realm of exports. For today's entrepreneur, a solid foundation in digital skills and their strategic application is not merely desirable [16, 17].

This research aims to bridge the gap identified above by developing a novel and robust framework for measuring digital literacy among entrepreneurs. By combining a strong theoretical base with a practical, applied focus, this study investigates how digital literacy impacts entrepreneurial performance, specifically exploring its influence on key financial and marketing outcomes. Central to our investigation is the mediating role of adaptive capability. We hypothesize that digital skills empower entrepreneurs to adapt and innovate in the face of rapid technological advancements and market shifts. Using data collected from entrepreneurs in Thailand provides a valuable context for examining these dynamics within a developing economy. We anticipate that this work will contribute meaningfully to the ongoing discussion of digital transformation, offering practical insights for entrepreneurs, policymakers, and business leaders seeking to harness the power of digital literacy for sustainable growth and competitiveness.

2. Literature Review

2.1. Digital Literacy for Entrepreneurs

Measuring digital skills is a relatively new concept that emerged not long ago. The framework for measuring digital literacy first arose from efforts to assess technological capabilities in the 1980s, when the internet and computers were just beginning to appear. Therefore, past terms for these skills might include ICT fluency, digital competency, or computer literacy, among others. With respect to the meaning of digital skills, various scholars and organizations have identified numerous concepts of digital knowledge. These include the ability to be aware of and possess technical skills in using information and communication technologies to search, evaluate, create, and communicate information as needed [18]. In addition, digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate, and create information securely and effectively through digital devices and network technologies, which is a form of participation in economic and social life [19]. This includes the awareness, attitudes, and abilities of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyze, and synthesize digital resources.

Spengler [20] further developed the idea that digital literacy is a combination of three skills: 1) Computer literacy, 2) Media literacy and 3) information literacy. Additionally, Ratanabanchuen [21] presented an analysis of digital literacy levels through knowledge in 5 subskills, including 1) cognitive skills, 2) soft skills, 3) digital business strategy skills or skills in digital business strategies, and 5) cybersecurity and data privacy skills or skills in cybersecurity and data protection in the digital world, with proficiency levels for each skill divided into levels 1 (lowest) to 5 (highest). In the context of business, digital literacy and digital culture significantly enhance business performance, innovation, profitability, and cost-effectiveness, which are used to measure organizational performance [22]. According to the research conducted by Ede [23], digital literacy demonstrates the ability to access the internet for searching, evaluating, and creating content via technology, as well as communicating effectively with others. Furthermore, SMEs should focus on developing digital knowledge, creativity, and innovation to optimize their products or services. This can be achieved by enhancing marketing strategies and boosting market competitiveness through workshops and the use of technology [24].

Recent studies consistently highlight the growing significance of digital literacy in shaping entrepreneurial success, particularly in an increasingly digitally driven economy. Novela et al. [25] emphasized that digital literacy directly enhances business performance by improving innovation, market engagement, and operational efficiency. Similarly, Budiarti & Firmansyah [26] reported that the level of digital skills affects economic competitiveness and impacts digital

transformation and innovation capability. In addition, Jasin et al. [27] reported that digital literacy plays a crucial role in knowledge management and process innovation, enabling SMEs to integrate digital tools for more efficient decision-making. In addition, Raharjo et al. [15] explored how digital literacy facilitates business transformation, noting that small enterprises equipped with strong digital skills are better prepared to embrace technological shifts and digital disruptions. Beyond transformation, Coco et al. [28] stress that digital training and government policies play crucial roles in bridging knowledge gaps, particularly for SMEs that struggle to keep pace with evolving digital trends.

Despite these insights, there remains a gap in the development of tailored assessment tools for digital literacy specifically designed for entrepreneurs in Thailand. Our study addresses this gap by developing a comprehensive assessment tool that can be used to evaluate and enhance digital literacy skills among Thai entrepreneurs. Despite the growing recognition of the importance of digital literacy, there remains a need for a more structured approach in assessing and developing the specific skills required for entrepreneurs. Recent research underscores that digital literacy is not merely about basic technology use but rather a broader competency that enhances business innovation, strategic decision-making, and adaptability in a rapidly evolving digital economy.

In this context, digital skills represent the ability to effectively utilize digital technology and information, encompassing both the technical knowledge and digital awareness necessary for work, learning, and participation in the digital economy. Building upon both domestic and international research, this study identifies four key components of digital skills that are essential for entrepreneurial success: the digital economy (DE), digital orientation (DO), dynamic capabilities (DC), and adaptive capability (AC).

2.2. Digital Economy

The digital economy is an economic system driven by digital technology and seamless connectivity, encompassing the production, distribution, and consumption of goods and services through digital platforms [29]. This aligns with Xu et al. [30], who define it as an economic system where data, digital technology, and connectivity are key factors in creating value and driving economic growth. The OECD [31] further emphasized that it is an economic system that integrates digital technology, data, and connectivity to create new economic activities and transform traditional business models.

The relationship between the digital economy and digital literacy is closely interconnected. Zhang & Zhang [32] reported that the population's digital literacy level directly affects digital economic growth, with countries with higher digital literacy levels tending to develop their digital economies more rapidly. This aligns with Chetty et al. [33] study, which indicates that developing workers' digital skills is crucial in driving digital economic growth. Additionally, Lei et al. [34] reported that organizations with digitally literate personnel have better competitive capabilities in the digital economic system.

Technology access and resource management are crucial components of the digital economy. Nwankpa et al. [35] indicated that efficient access to digital technology enhances business opportunities and innovation development. Zhang et al. [36] reported that digital resource management capability affects organizational operational efficiency in the digital economic system. This aligns with Thompson & Brown [37], who emphasize that integrating technology access and efficient resource management is key to creating competitive advantages in the digital era.

On the basis of the comprehensive literature review and theoretical foundations discussed, the digital economy in this research framework is conceptualized as the ability to use digital tools and technologies for data management, analysis, and organizational communication. This encompasses searching for and accessing data from reliable sources, using enterprise resource management systems such as ERP and CRM, applying artificial intelligence (AI) in data analysis, and systematically storing and managing digital data, with a focus on improving operational efficiency and reducing organizational costs.

2.3. Digital Orientation

Digital orientation has been defined by Westerman et al. [38] as having a clear digital direction that enables organizations to create significant business transformations. This involves not only implementing new technologies but also adjusting strategies and work methods to align with changes in the digital world. Similarly, Bharadwaj [39] stated that the ability to use information technology and having a strong digital orientation are factors that can enhance organizational efficiency and effectiveness. The use of technology must be integrated into various processes, such as customer data analysis or the development of new products that meet market demands.

Digital orientation has garnered attention in various contexts, particularly in the areas of organizational development and sustainable economies. Research findings indicate that digital orientation positively impacts organizational resilience through the use of dynamic capabilities to better cope with technological changes [40]. Similarly, digital orientation and digital eco-innovation promote circular economy development and help achieve sustainable development goals by focusing on the link between technology and resource management [41].

Current studies of digital orientation components emphasize two main dimensions: learning and adaptive capabilities and customer-centric attitudes. Liu et al. [40] reported that organizations with high digital orientation demonstrate their ability to learn and adapt to technological changes, particularly in developing personnel skills and applying new technologies in business operations. This aligns with Mishra et al. [42], who indicate that organizations with high digital orientation focus on using digital technology to respond to customer needs and continuously create positive experiences. Furthermore, Browder et al. [43] study shows that organizations that are successful in digital adaptation typically possess both the ability to analyze customer data to identify new business opportunities and the readiness to invest in technology to increase customer service.

Therefore, digital orientation in this study refers to an organization's approach and attitude in using digital technology to drive business, encompassing readiness to invest in technology, continuous personnel skill development, seeking new business opportunities, responding to customer needs, analyzing data to identify business opportunities, and the ability to use digital technology to reach new customer segments.

2.4. Dynamic Capability

Dynamic Capabilities (DC) refer to the ability of an organization to integrate, build, and reconfigure internal and external competencies to adapt to rapidly changing environments [44]. These capabilities are fundamental resources that differentiate organizations and drive competitive advantage by fostering adaptation, innovation, and strategic execution in uncertain contexts [45]. DCs involve specific processes that can be nurtured, such as integrative capabilities to synthesize knowledge [46] and leveraging resources to improve market competitiveness [47]. Dynamic capability plays a crucial role in enhancing digital literacy, enabling organizations to adapt effectively to technological advancements and maintain competitiveness in the digital age. As organizations increasingly rely on digital tools, the synergy between DCs and digital literacy becomes critical for strategic decision-making and innovation. Studies after 2015 emphasized that higher digital literacy equips managers to leverage data and technology, fostering resilience and competitive advantage in a volatile market [48, 49]. Modern research has identified the key components of dynamic capability as strategic thinking, planning, and innovation. Strategic planning helps organizations navigate changes, whereas innovation drives the creation of new products and processes. Recent studies (post-2020) highlight the importance of these elements in fostering organizational growth and adapting to global market demands [50, 51]. Digital transformations further reinforce these capabilities, integrating them into sustainable practices and decision-making frameworks.

Dynamic capability, as defined in this research, encompasses an organization's ability to continuously adapt and develop resources, processes, and strategies to navigate complex and uncertain environments. This involves leveraging internal competencies, fostering innovation, and integrating digital tools to ensure long-term competitiveness and resilience.

2.5. Adaptive Capability

Adaptive capability (AC) is a vital organizational trait that enables firms to adjust to changing environments and capitalize on emerging opportunities. Chakravarthy [52] defines adaptability as an organization's ability to monitor, prepare for, and respond effectively to business opportunities, leveraging them to achieve competitive advantage. This concept emphasizes the importance of flexibility, learning, and innovation in navigating uncertain and complex environments. Gibson and Birkinshaw [53] further elaborate that AC involves modifying behaviors, processes, and organizational structures to align with shifting market demands. Additionally, Wang and Ahmed [54] highlight that AC fosters innovation by facilitating resource mobilization and swift, appropriate responses to environmental changes.

In the digital era, adaptive capability and digital literacy are closely intertwined. Digital literacy enhances an organization's ability to utilize technological tools and data effectively, which in turn strengthens adaptability. Moreover, organizations with robust adaptive capabilities can integrate digital skills to foster innovation and decision-making. Kuo [55] demonstrated that AC, coupled with big data analytics, significantly boosts innovation performance by enabling swift responses to market changes. Similarly, Arraya [56] noted that AC plays a mediating role in leveraging digital tools for organizational resilience, particularly in SMEs.

Modern research has identified several key components of adaptive capability that are critical for organizational success. These include data analysis and synthesis, problem-solving and critical thinking, communication skills, and awareness of cybersecurity and safety. Akgün et al. [57] emphasized that these components are integral to enhancing organizational outcomes in the digital economy. Recent studies also reveal that leveraging adaptive capabilities for data-driven decision-making improves problem-solving efficiency and supports strategic initiatives. Moreover, communication skills and cybersecurity awareness are essential for fostering trust and ensuring operational safety in an increasingly digital landscape [55, 58].

In this research context, adaptive capability is defined as an organization's ability to effectively adjust strategies, processes, and resources to navigate dynamic and complex environments. It encompasses data-driven decision-making, critical thinking, and the application of digital tools, all of which are essential for fostering innovation and maintaining competitiveness in a rapidly evolving digital economy.

On the basis of the literature and research review, the four variables are interconnected in reflecting entrepreneurs' digital literacy levels. The digital economy demonstrates the ability to operate in a digital economic system that enhances competitive advantage and data accessibility. Digital orientation reflects organizational readiness for transformation and efficient technology utilization. Dynamic capability and adaptive capability indicate an organization's ability to adapt, develop, and create long-term competitive advantages. All these components are essential for business operations in the rapidly changing digital era. Therefore, the researcher selected these four variables to reflect the digital literacy level of Thai entrepreneurs.

2.6. Business Performance

2.6.1. Financial Performance

Financial performance (FP) is the measurement and evaluation of the overall financial status of an organization, considering all key financial components, including assets, liabilities, owners' equity, expenses, income, and profitability. This is assessed through various business calculation formulas to accurately determine the true potential of the organization [59]. According to Li et al. [60], digital literacy impacts the financial performance of businesses in multiple dimensions, affecting the development of capabilities at two main levels: the managerial level and the organizational level. At the managerial level, digital literacy helps develop dynamic managerial capabilities by improving the mindset and vision of executives, building and expanding business relationship networks, and enhancing the ability to create and develop high-potential teams. Digital literacy helps develop dynamic managerial capabilities by improving the mindset and vision of executives, building and expanding business relationship networks, and increasing the ability to create and develop high-potential teams. At the organizational level, digital literacy enhances organizational capabilities in terms of the use of digital platforms, business development, and the ability to adapt to market changes. The financial outcomes resulting from the development of digital literacy can be measured by various indicators, including revenue growth, increase in net profit, improvement in return on both assets and equity, reduction in operating costs, and improvement in the gross profit margin. Asyari et al. [61] studied the moderation effect of work motivation. The effect of digital competence on bank employee performance shows that digital competency is crucial for the financial performance of organizations. The study results revealed a statistically significant positive relationship. The direct impact of digital competence is demonstrated through increased work efficiency and productivity, reduced errors, and enhanced accuracy in operations, as well as the ability to foster innovation and respond to rapidly changing market demands.

Avirutha [62] studied the impact of the digital transformation of businesses on the performance of SMEs in the Thailand 4.0 era. The research findings indicate that digital readiness has a positive effect on the transition to digital, and the transition to digital positively affects business performance in terms of finance, marketing, internal processes, and learning and growth. These findings demonstrate that digital literacy is a crucial factor that directly influences the financial performance of organizations in the digital era. Research findings across multiple studies support the conclusion that digital literacy directly influences financial performance.

H₁: Digital literacy significantly directly influences financial performance.

2.6.2. Marketing Performance

Marketing performance (MP) is the measurement and management of marketing performance used to evaluate the efficiency and effectiveness of marketing activities via various indicators. In terms of finance, organizations consider net profit, sales revenue, return on investment, marketing costs and expenses, and increased market value. Additionally, there are nonfinancial indicators, including market share. The market shares customer satisfaction, the customer retention rate, brand awareness, and brand equity [63]. Puro & Achmad [64] studied the influence of digital knowledge and digital skills on the marketing strategies of SMEs in the Solo Raya area of Indonesia. The research findings indicate that both digital knowledge and digital skills have a statistically significant positive effect on marketing strategies. Patria et al. [65] studied the influence of digital technology, digital knowledge, and digital marketing on the performance of SMEs in the Bekasi area of Indonesia. The research findings revealed that all three factors had a significant positive effect on the performance of SMEs. Nurlina et al. [66] studied the impact of digital literacy and business strategies on the performance of micro, small-, and medium-sized enterprises (MSMEs) in the food industry in Padang, Indonesia. The research findings indicate that digital literacy and business strategy have a significantly positive effect on the performance of MSMEs, both in a segmented and holistic manner. The research findings indicate that having digital literacy and appropriate business strategies can enhance the operational efficiency of small businesses, which is consistent with the findings of Patria et al. [65], who studied the influences of digital technology, digital literacy, and digital marketing on the performance of SMEs in Bekasi. The research findings indicate that digital literacy, or the knowledge and skills involved in the use of digital technology, has a significantly positive effect on the operational performance of SMEs in the city of Bekasi. Digital literacy helps SMEs operate their businesses more easily, reach more customers, and obtain useful information for their businesses.

The development of digital literacy is therefore an important factor that entrepreneurs should prioritize. It is essential to provide training and develop digital skills alongside entrepreneurial skills to increase the efficiency of sustainable

business operations. Digital knowledge and understanding are therefore among the three main factors (along with digital technology and digital marketing) that affect the success of SMEs in the digital era. On the basis of the previous discussion, this study proposed hypothesis H_2 , namely, the impact of digital literacy on marketing performance.

H_2 : Digital literacy significantly directly influences marketing performance.

2.7. Conceptual Framework

As shown in Figure 1, digital literacy in this conceptual framework serves as a mediating variable that connects the relationships between key components of digital capabilities and business performance outcomes. The framework illustrates how 4 independent variables influence business success through digital literacy. These independent variables include the digital economy (DE), digital orientation (DO), dynamic capability (DC), and adaptive capability (AC). The mediating role of digital literacy (DL) demonstrates how these 4 components indirectly affect 2 dependent variables: financial performance (FP) and marketing performance (MP). This mediation effect is represented by hypotheses H_1 and H_2 , which indicate the influence relationships between digital literacy and both performance measures.

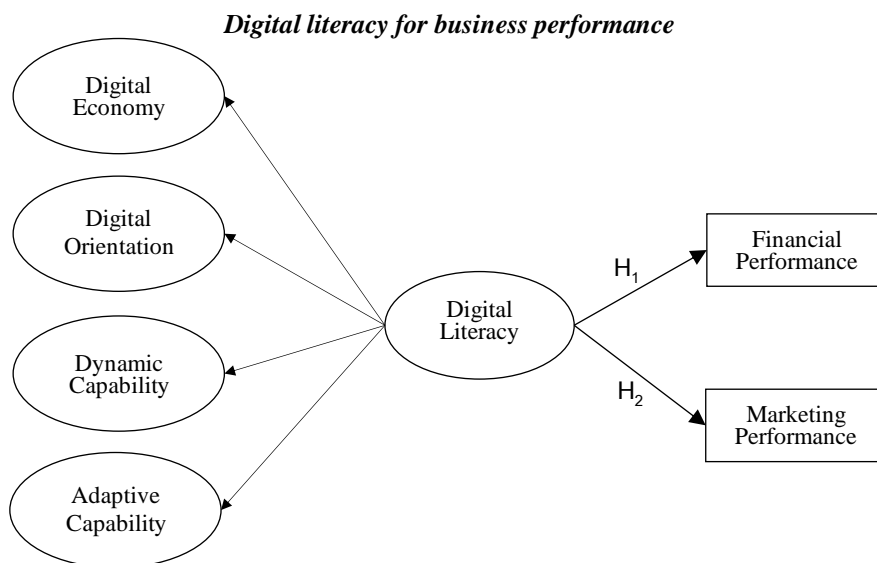


Figure 1. Conceptual Framework

3. Research Methodology

This study investigates the factors influencing digital literacy levels among Thai entrepreneurs. Guided by the conceptual framework depicted in Figure 2, a quantitative approach is employed, utilizing confirmatory factor analysis (CFA) to assess the validity of the measurement model. Structural equation modeling (SEM) is then used to test the hypothesized causal relationships between the latent variables representing digital literacy, its antecedents (digital economy, digital orientation, dynamic capability, and adaptive capability), and entrepreneurial outcomes (financial performance and marketing performance). The questionnaire items, which serve as observed variables, measure these underlying constructs, enabling an examination of both direct and indirect effects within the model. This process allows for the empirical validation of the theoretical framework, determining how well the hypothesized relationships align with the collected data and providing insights into the complex interplay of factors driving digital literacy and entrepreneurial success. The analysis aims to identify the key drivers of digital literacy and assess their impact on business performance.

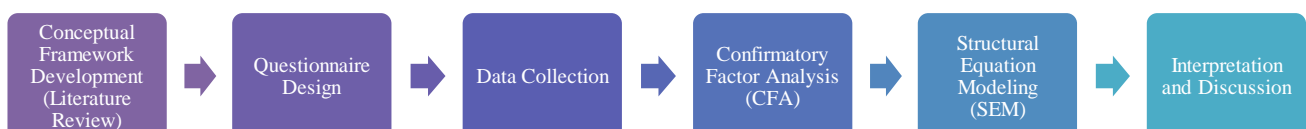


Figure 2. Methodology Process

3.1. Participant and Data Collection

The population for this study comprised members of the provincial chambers of commerce across Thailand as of March 2024. This included a total of 60,554 members, distributed as follows: 9,340 from the northern region, 11,097 from the central region, 5,059 from the eastern region, 25,632 from the northeastern region, and 9,426 from the southern

region [67]. A nonprobability purposive sampling method was employed to select participants aligned with the research objectives. The data were collected via a 5-point Likert scale. Following the recommendations of Hair et al. [68] for sample size determination in structural equation modeling (SEM) and considering the guidance provided by Hair et al. [68] for studies with a similar number of constructs and indicators, a sample size of 354 entrepreneurs was deemed appropriate. This sample size, coupled with the sampling strategy, ensured sufficient statistical power for the analyses. The diversity of regional representation within the chambers of commerce, along with the inclusion of small and medium-sized enterprises (SMEs), which are vital to the Thai economy, enhances the generalizability and practical relevance of the findings. Thailand's position as a regional hub for the digital economy further justifies its selection as a pertinent context for examining the interplay between digital literacy and entrepreneurial performance.

3.2. Instrument

A questionnaire was developed to assess entrepreneurs' digital literacy, aligning with the conceptual framework of the study. Prior to deployment, the instrument's validity was evaluated via expert review. A pilot test was then conducted with a sample of 30 entrepreneurs selected via simple random sampling. The reliability of the pilot data was assessed via Cronbach's alpha [69]. The resulting coefficient for the full questionnaire was 0.964, exceeding the recommended threshold of 0.7 [70], thus demonstrating strong internal consistency and justifying its use for data collection with the main sample. The questionnaire consisted of three sections. Part 1 gathered demographic information from the respondents, including gender, age, education level, business management experience, entrepreneur type, industry, years in operation, and number of employees. Part 2 assessed digital literacy across the four dimensions identified in the conceptual framework: the digital economy, digital orientation, dynamic capability, and adaptive capability. This section comprises 30 items, each measured on a 5-point Likert scale. The Cronbach's alpha for this section was 0.94, indicating excellent reliability. Finally, Part 3 evaluated financial and marketing performance via 14 items, also measured on a 5-point Likert scale, achieving a Cronbach's alpha of 0.93 [71], demonstrating robust internal consistency.

3.3. Data Analysis

Data analysis was conducted via statistical software. Descriptive statistics were generated via SPSS (Statistical Package for the Social Sciences). To test the hypothesized relationships outlined in the conceptual model, structural equation modeling (SEM) was performed via AMOS (Analysis of Moment Structures).

3.3.1. Descriptive Analysis

Descriptive statistical analyses were performed on the demographic data collected in Part 1 of the questionnaire, including gender, age, education level, business management experience, entrepreneur type, industry classification, years in operation, and number of employees. The frequency distributions and percentages were used to summarize these categorical variables. For the four dimensions of digital literacy assessed in Part 2 (digital economy, digital orientation, dynamic capability, and adaptive capability), means and standard deviations were calculated to describe the central tendency and dispersion of scores for each dimension.

3.3.2. Statistical Analysis

Causal modeling was performed via confirmatory factor analysis (CFA) and structural equation modeling (SEM) within the AMOS software environment to investigate the relationships between variables, as depicted in the research framework. A range of fit indices was employed to evaluate the adequacy of the proposed model. These included chi-square statistics (with a target value of <5.00), the comparative fit index (CFI), the normed fit index (NFI), and the Tucker–Lewis index (TLI), all with recommended values of ≥ 0.90 , and the root mean square error of approximation (RMSEA), with a suggested value of ≤ 0.10 . These criteria, which are consistent with established guidelines [72–74], provide a robust basis for assessing model fit.

4. Results

4.1. Demographics Characteristics of the Respondents

The demographic characteristics of the respondents are shown in Table 1. The status of the respondents classified by gender shows that the majority are male, totaling 204 people, 57.63% of whom are male. The age group is predominantly 30–39 years, with 107 people, accounting for 30.23% of the sample. The highest level of education is a bachelor's degree, with 230 people, accounting for 64.97% of the sample. There were more than 10 years of experience in business management, with 152 people, accounting for 42.94% of the sample. Businesses byproduct type are in the service group, with 152 people, accounting for 42.94%. The number of years in business for 10 years or more is 168 people, accounting for 47.46%, and the number of employees in the business is approximately 11–50 people, totaling 142 people, accounting for 40.11%.

Table 1. Demographics characteristics of the respondents

Characteristic	Description	Frequency (n)	Percentage (%)
Gender	Male	204	57.63
	Female	131	37.01
	Not specified	19	5.37
Age Group	Less than 18 years	0	0
	18- 29 years	33	9.32
	30-39 years	107	30.23
	40-49 years	88	24.86
	50-59 years	81	22.88
	60-69 years	36	10.17
	More than 70 years	9	2.54
Education	Below Graduation	22	6.21
	Graduation	230	64.97
	Master's Degree	92	25.99
	Doctoral Degree	7	1.98
	Other	3	0.85
Business Administration Experience	Less than 1 year	14	3.95
	1-4 years	63	17.8
	5-10 years	125	35.31
	More than 10 years	152	42.94
Types of Entrepreneurs	Sole Proprietorship	103	29.1
	Partnership	72	20.34
	Limited Company	151	42.66
	Public Limited Company	7	1.98
	Cooperative	1	0.28
	Social Enterprise	12	3.39
	Other	8	2.26
Types of Business by Product Category	Agro & Food Industry	74	20.9
	Financial Business	18	5.08
	Industrial Products	40	11.3
	Services	126	35.59
	Property & Construction	43	12.15
	Resources	6	1.69
	Technology	21	5.93
	Other	26	7.34
Years in Business Operation	Less than 1 year	15	4.24
	1-3 years	47	13.28
	4-7 years	67	18.93
	8-10 years	57	16.1
	More than 10 years	168	47.46
Number of Employees	1-10 employees	140	39.55
	11-50 employees	142	40.11
	51-100 employees	43	12.15
	101-200 employees	13	3.67
	201-500 employees	13	3.67
	More than 500 employees	3	0.85

4.2. Reliability and Validity Testing

Table 2 presents a comprehensive assessment of the measurement model's reliability and validity. The analysis reveals strong factor loadings (λ) across all the items. The measured constructs demonstrated satisfactory internal consistency, with both Cronbach's alpha (α) and composite reliability (CR) values surpassing 0.6 [69]. Moreover, the average variance extracted (AVE) values exceeded 0.5 for all the constructs, confirming adequate convergent validity [69]. These findings substantiate the measurement model's reliability and validity, providing a robust foundation for subsequent structural equation modeling to test the proposed hypotheses.

Table 2. Reliability and Validity Testing Results

Construct	Observed Variables	Description of Items	Factor Loading (λ)
Digital Economy (DE)	DE1	You can search for and utilize digital tools to efficiently access, manage, and analyze data from credible sources	0.618
	DE2	Your business uses technology to efficiently manage systems and support internal communication within the organization	0.818
	DE3	You can use AI to work and analyze data	0.654
α : 0.903 CR: 0.656 AVE: 0.597	DE4	You can use your knowledge of digital data storage to efficiently support business management and operations	0.841
	DE5	Using technology helps your business become more efficient	0.791
	DE6	You can choose to use digital technology to help manage tasks and reduce operational costs	0.797
	DE7	You can use digital systems such as ERP or CRM systems to efficiently support the management and administration of resources within the organization	0.855
Digital Orientation (DO)	DO1	You are willing to expand your knowledge about new technologies	0.533
	DO2	You are ready to invest in implementing technology in your organization's operations	0.663
	DO3	You continuously develop your organization's personnel skills in technology	0.763
	DO4	You seek new opportunities in business operations while learning and adapting to efficiently implement technology within the organization	0.779
	DO5	Using digital technology helps your business to respond to and meet customer needs conveniently and faster	0.900
	DO6	You can analyze customer data to find new business opportunities	0.774
	DO7	You have the ability to use digital technology to reach new customer groups	0.821
Dynamic Capability (DC)	DC1	You have the ability to foresee changes in business or industry and find operational strategies to accommodate new technologies	0.721
	DC2	You have the flexibility to adapt business strategies when faced with technological changes	0.747
α : 0.914 CR: 0.665 AVE: 0.608	DC3	You can use technology to plan and drive business to explore and penetrate new markets	0.820
	DC4	You have implemented technology in your operational planning to align with your business vision and goals	0.816
	DC5	You have created a culture within the organization that emphasizes the importance of digital technology	0.757
	DC6	You have the ability to create or present new products or services using technology to improve and develop your business	0.818
	DC7	You can apply media to present and disseminate your work.	0.774
Adaptive Capability (AC)	AC1	You use digital technology to analyze market data, make business decisions, and develop processes that add value to your business	0.875
	AC2	You have the ability to use digital technology to analyze and solve business problems in a systematic and creative manner	0.871
α : 0.928 CR: 0.642 AVE: 0.579	AC3	You have knowledge and understanding of cybersecurity technology and can plan or strategize to appropriately address technology risks	0.859
	AC4	You have the ability to handle challenges from competitors using technology	0.761
	AC5	You can communicate with customers through online channels	0.595
	AC6	You can use digital technology to efficiently communicate and convey ideas with the business supply chain	0.729
	AC7	You have the ability to secure digital information and technology systems, as well as monitor and implement appropriate cybersecurity measures	0.783
	AC8	You are aware of setting privacy policies and using customer data	0.610
	AC9	You instill digital security awareness in your employees	0.704
Financial Performance (FP)	FP1	Using digital technology helps your organization increase its revenue	0.799
	FP2	Using digital technology helps your organization increase its points	0.803
α : 0.904 CR: 0.706 AVE: 0.661	FP3	Using digital technology helps your organization offer products or services that stand out from competitors.	0.806
	FP4	Using digital technology helps your organization efficiently manage costs and reduce operational expenses	0.844
Marketing Performance (MP)	MP1	Using digital technology helps your organization respond to customer needs	0.792
	MP2	Using digital technology helps enhance the organization's image and brand strength, while also increasing the chances of repeat purchases from customers	0.861
α : 0.928 CR: 0.784 AVE: 0.761	MP3	Using digital technology helps your organization increase its market share and efficiently reach new markets	0.952
	MP4	Using digital technology helps your organization adapt to market changes faster	0.896
	MP5	Using digital technology helps your organization increase its distribution channels	0.852

4.3. Confirm Factor Loading

To establish construct validity, this study employed confirmatory factor analysis (CFA) for all 4 latent independent variables: digital economy (DE), digital orientation (DO), dynamic capability (DC), adaptive capability (AC), and 2 latent dependent variables: financial performance (FP) and marketing performance (MP). The purpose of this analysis is to confirm the structure of the latent variables and their relationships with the observed variables within each construct. The results of the analysis are presented in Table 3, which provides standardized estimates (β), unstandardized estimates (b), standard errors (S.E.) and R-squared values (R²). Confirmatory factor analysis (CFA) was used to evaluate how well the indicators represented their respective latent variables and assess the relationships between the constructs.

Table 3. Confirm Factor Loading for Construct Variables

Construct Variables	Digital Literacy (DL)				R ²
	β	b	S.E.	t	
DE	0.913***	1.081	0.056	19.201	0.833
DO	0.890***	0.873	0.048	18.614	0.792
DC	0.927***	0.859	0.051	16.842	0.860
AC	0.999***	1.000	-	-	0.999
FP	0.905***	0.875	0.048	18.302	0.818
MP	0.823***	0.875	0.046	19.180	0.678

The confirmatory factor analysis of the digital literacy latent variable revealed that all the variables demonstrated high standardized factor loadings, ranging from 0.823--0.999. When the t values were examined, all the variables were statistically significant at the 0.001 level, indicating that all the variables are essential components of digital literacy. Furthermore, the standard errors (S.E.) were found to be low, ranging from 0.046--0.056, demonstrating high precision in parameter estimation. With respect to the coefficient of determination (R²), which indicates the ability to explain the variance of the digital literacy latent variable, the AC variable had the highest R² at 0.999, followed by DC at 0.860 and DE at 0.833. The analysis demonstrates that the digital literacy measurement model is appropriate, with all the variables showing statistically significant relationships with digital literacy and effectively measuring digital literacy characteristics.

The measurement model fit analysis in Table 4 demonstrates that the revised model achieved superior fit compared with the initial model across all indices. Specifically, the chi-square per degree of freedom (χ^2/df) decreased from 3.884 to 2.155, well below the recommended threshold of 5.00, indicating improved parsimony. The comparative fit index (CFI) improved from 0.845 to 0.943, exceeding the threshold of 0.90, suggesting a better relative fit than that of the null model. Similarly, the normed fit index (NFI) increased from 0.802 to 0.900, and the Tucker–Lewis index (TLI) improved from 0.835 to 0.934, both surpassing the 0.90 criterion, which indicates good incremental fit. The root mean square error of approximation (RMSEA) decreased from 0.090 to 0.057, falling well within the acceptable range of less than 0.10, suggesting a reasonable approximation error. These comprehensive fit indices collectively provide strong evidence that the revised measurement model has excellent fit with the empirical data, validating the structural relationships hypothesized in the research model.

Table 4. Measurement model fit of the proposed model

Statistics	Desired Value	Initial Model	Revised Model	Result
χ^2/df	≤ 5.00	3.884	2.155	Qualified
CFI	≥ 0.90	0.845	0.943	Qualified
NFI	≥ 0.90	0.802	0.900	Qualified
TLI	≥ 0.90	0.835	0.934	Qualified
RMSEA	≥ 0.10	0.090	0.057	Qualified

4.4. Hypothesis Testing

Table 5 shows that the hypothesis testing results reveal that digital literacy has significant positive effects on both performance dimensions. Specifically, digital literacy significantly influences financial performance ($\beta = .905$, $t = 18.302$, $p < 0.001$) and marketing performance ($\beta = 0.823$, $t = 19.180$, $p < 0.001$), supporting both H₁ and H₂. These findings demonstrate that the development of digital literacy plays a crucial role in enhancing both the financial and marketing performance outcomes of organizations.

Table 5. Summary of Hypothesis Testing

	β	t	Result
H ₁ : Digital Literacy → Financial Performance	0.905***	18.302	Supported
H ₂ : Digital Literacy → Marketing Performance	0.823***	19.180	Supported

5. Discussion

This study demonstrates the significant positive impact of digital literacy on Thai entrepreneurs' financial and marketing performance. Specifically, digital literacy positively influenced financial performance ($\beta = .905$, p value $< .001$) and marketing performance ($\beta = .823$, p value $< .001$). These findings confirm that digital literacy acts as a crucial mediating factor, linking the four digital capabilities—digital economy (DE), digital orientation (DO), dynamic capability (DC), and adaptive capability (AC)—with entrepreneurial performance outcomes. These results align with research emphasizing the positive relationship between digital literacy and business performance at both the managerial and organizational levels. Our findings Li et al. [60] observations that, at the managerial level, digital literacy enhances strategic decision-making and fosters innovation, whereas at the organizational level, it improves operational efficiency and market responsiveness. Furthermore, this study provides empirical support for Teece et al. [44] dynamic capabilities framework, demonstrating the crucial role of integrating, building, and reconfiguring competencies for navigating the complexities of the digital age. As they argued, in rapidly changing environments, firms must possess the ability to sense, seize, and reconfigure resources to maintain a competitive advantage. Our research suggests that digital literacy is a crucial resource that enables these dynamic capabilities.

Research findings suggest that Thai entrepreneurs should focus on developing digital literacy skills in four key areas to enhance business performance. Adaptive capability skills ($\beta=0.999$) had the greatest influence, comprising data analysis, problem-solving, and cybersecurity. This resonates with the concept of organizational ambidexterity, as described by Gibson & Birkinshaw (2004) [53], highlighting the importance of organizational flexibility and responsiveness in the digital economy. Our research extends this line of inquiry by providing specific examples of how Thai entrepreneurs utilize digital tools such as ERP systems to increase financial efficiency and social media platforms to improve marketing effectiveness to achieve these outcomes. This contributes to the growing body of literature exploring the connection between digital skills and entrepreneurial success. However, *while previous research has often focused on the broad impact of digital literacy, this study delves deeper, examining the specific dimensions of digital capability and their relative importance in the context of Thai entrepreneurs.* For example, while some studies may have treated digital literacy as a monolithic construct, our findings suggest that adaptive capability plays a particularly crucial role, potentially reflecting the dynamic nature of the Thai digital market. This nuanced understanding of the relationship between digital literacy and entrepreneurial performance is a key contribution of this research. Moreover, the focus on Thai entrepreneurs provides valuable insights into the specific challenges and opportunities faced by businesses in a developing economy undergoing rapid digital transformation. This context adds a layer of complexity not always captured in studies conducted in more developed economies, where digital infrastructure and access may be more established. Future research could explore these contextual factors in greater detail, comparing the experiences of entrepreneurs in different stages of economic development.

5.1. Theoretical Contributions

This study makes a significant theoretical contribution by conceptualizing digital literacy as a multidimensional construct that integrates dynamic capability (DC), adaptive capability (AC), digital economy (DE), and digital orientation (DO) theories. This approach departs from more traditional perspectives on digital literacy, which have often focused on technical skills or access to technology [1-3]. Instead, this study emphasizes the behavioral and strategic dimensions of digital literacy, positioning it as a critical enabler of entrepreneurial success in the contemporary business environment. *This aligns with calls for a more nuanced understanding of digital literacy that goes beyond basic skills and encompasses the ability to effectively utilize digital resources for strategic advantage* [18-20]. This work also contributes to the advancement of dynamic capability theory [44]. It does so by explicitly *demonstrating how digital literacy empowers entrepreneurs not only to sense and seize opportunities arising from technological and market shifts* [45- 47] *but also to effectively reconfigure their resources and strategies to adapt to these changes* [48-50]. This extends the theory by highlighting the critical role of digital literacy as an underlying mechanism through which dynamic capabilities are enacted in the digital age. This builds upon existing research that has examined the role of dynamic capabilities in digital transformation [38-43] but goes further by specifically focusing on the connection between digital literacy and these capabilities.

Furthermore, this research enriches adaptive capability theory [52-54] by demonstrating how digital literacy enhances organizational flexibility and resilience, enabling entrepreneurs to navigate the uncertainties inherent in rapidly evolving digital landscapes and to innovate more effectively [55-58]. *Our study suggests that digital literacy is not only about reacting to change but also about proactively shaping it.* This finding is consistent with recent research that emphasized

the importance of adaptive capabilities for firm success in dynamic environments [56, 57]. By examining the relationship between digital literacy and adaptive capability, this study helps clarify how organizations can develop the ability to learn, adapt, and innovate in the face of change. By grounding digital literacy within the frameworks of the digital economy (DE) [30-32] and digital orientation (DO) [40-42], *this research offers a novel perspective on how digitally related competencies influence human behavior, decision-making, and overall organizational strategy*. This integration illuminates digital literacy's foundational role in bridging individual entrepreneurial characteristics with broader economic and organizational dynamics. Unlike prior research that has treated these concepts in isolation, this study provides a more holistic view of how digital literacy functions within the complex interplay of individual skills, organizational capabilities, and the broader digital economy. In summary, this study contributes to theory by: (1) conceptualizing digital literacy as a multidimensional construct encompassing strategic and behavioral aspects; (2) demonstrating its role in enabling dynamic capabilities in the digital age; (3) clarifying its contribution to adaptive capability and organizational resilience; and (4) integrating these insights within the frameworks of DE and DO to offer a more nuanced understanding of the impact of digital literacy on entrepreneurial success.

5.2. Managerial Implication

This study has practical implications for private sector organizations, particularly SMEs. Entrepreneurs can leverage these findings to prioritize digital skill development initiatives, enabling them to respond effectively to technological advancements and competitive pressures. *Businesses should invest in comprehensive digital training programs, implement tools for efficient data management, and adopt digital platforms such as e-commerce and social media to expand market reach*. Moreover, the integration of robust evaluation tools to measure both digital and human-centric skills is crucial. These tools should be aligned with relevant entrepreneurial theories and frameworks, allowing organizations to systematically assess existing skill levels, pinpoint areas for improvement, and monitor progress in skill enhancement. Such assessments can also inform the design of targeted upskilling initiatives that emphasize not only technical proficiencies but also crucial human-centric skills such as critical thinking, adaptability, and innovation. Policymakers and industry leaders can utilize this research to develop focused initiatives that support SMEs in navigating digital transformation, ultimately fostering innovation and sustainability within the entrepreneurial ecosystem.

6. Conclusion

This study provides compelling evidence for the crucial role of digital literacy in driving the financial and marketing performance of Thai entrepreneurs. The findings underscore that digital literacy is not merely a set of technical skills but also a multifaceted capability encompassing strategic thinking, innovation, and adaptability. By integrating dynamic capability, adaptive capability, the digital economy, and digital orientation theories, this research offers a nuanced understanding of how digital literacy empowers entrepreneurs to navigate the complexities of the digital age. Specifically, this study demonstrates that digital literacy acts as a powerful mediating factor between key digital capabilities and business outcomes. Entrepreneurs with higher levels of digital literacy are better equipped to sense, seize, and reconfigure resources in response to dynamic market conditions, ultimately leading to enhanced financial and marketing performance. The particularly strong influence of adaptive capability highlights the critical importance of flexibility and responsiveness in today's digital economy. These findings have significant implications for entrepreneurs, policymakers, and business leaders. By investing in comprehensive digital literacy development programs that emphasize both technical skills and strategic capabilities, stakeholders can empower entrepreneurs to thrive in the digital marketplace. This research underscores the need for a holistic approach to digital literacy development, one that fosters not only technical proficiency but also the ability to adapt, innovate, and leverage digital technologies for business growth. As the digital landscape continues to evolve, such integrated approaches will be essential for ensuring the continued success and competitiveness of entrepreneurs in Thailand and beyond.

6.1. Limitations

Despite its contributions, this study has several limitations. First, it relies on cross-sectional data, limiting the ability to establish causality or observe changes over time. Second, the data are predominantly subjective, as they were collected via self-report questionnaires, which may introduce biases on the basis of individual perceptions. Third, the research focuses solely on Thailand, which may restrict the generalizability of the findings to other cultural or economic contexts.

6.2. Future Research

Future research should address these limitations by incorporating longitudinal designs to track changes in digital literacy and entrepreneurial performance over time. Additionally, the inclusion of objective measures, such as business financial data or digital proficiency tests, could complement self-reported data for a more comprehensive analysis. Expanding the study to include international comparative analyses and exploring the roles of additional variables, such as organizational culture or leadership styles, could further enhance the understanding of the mechanisms underlying the impact of digital literacy on entrepreneurial success.

7. Declarations

7.1. Author Contributions

Conceptualization, R.A. and W.P.; methodology, R.A. and D.H.; software, R.A. and D.H.; validation, R.A., W.P., and D.H.; formal analysis, R.A.; investigation, R.A.; resources, R.A. and W.P.; data curation, R.A.; writing—original draft preparation, R.A.; writing—review and editing, W.P. and D.H.; visualization, R.A.; supervision, W.P.; project administration, R.A.; funding acquisition, R.A. All authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

The data presented in this study are available in the article.

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The authors received no financial support for the research, authorship, and/or publication of this article.

7.4. Institutional Review Board Statement

Not applicable.

7.5. Informed Consent Statement

Not applicable.

7.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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