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Assessing Digital Business Sustainability in Thai SMEs: A Study Using Rough Set-Delphi Method and Confirmatory Factor Analysis

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Abstract

Aim: To assess the confirmatory factor analysis model of digital business sustainability in small and medium enterprises (SMEs) in Thailand, evaluating effective business strategies that will lead to long-term resilience in the digital economy. Methods: The research uses the e-Rough Set Delphi technique to gather expert opinions from 20 experts, divided into three groups: government sector representatives (7 experts), university lecturers in entrepreneurship (6 experts), and successful digital entrepreneurs from SMEs (7 experts). This approach allows for a comprehensive understanding of the factors influencing digital business sustainability. Results: Findings confirm that the proposed sustainability model is reliable and well-structured. It identifies key factors that drive the sustainable development of SMEs, with digital transformation being crucial for increasing competitiveness and adaptability. Implications: the implications are practical for policymakers and business leaders in developing strategic frameworks to support SMEs resilience in the rapidly evolving digital environment. Conclusion: This study contributes to existing literature by proposing a new procedure that combines rough set theory and the Delphi method to measure expert consensus. The research significantly advances the development of tailored strategies to support the sustainability of SMEs in the Thai context and provides a model for economies facing digital disruption.

Keywords: *Digital Business, Thai SMEs, Rough Set-Delphi, Confirmatory Factor Analysis, Sustainability.*

Introduction

Development of a method to measure the consensus of the expert group using the rough set theory. In the electronic Delphi technique, this research aims to develop a method to measure the consensus of the expert group. To obtain a new method to measure the consensus of the expert group in the electronic Delphi technique using the rough set theory to deal with the ambiguity and uncertainty of the specialist opinion data, making the questions obtained from the expert group consensus more accurate. The rough set theory was first introduced by Pawlak et al. (1995), as a new mathematical approach to set and uncertainty of set members. Unlike fuzzy, the uncertainty of a rough set does not require probability or probability values to handle the ambiguity. Still, it uses a simpler concept using lower approximation and upper approximation, applied to cluster data, namely approximation space, as shown in Figure 1.

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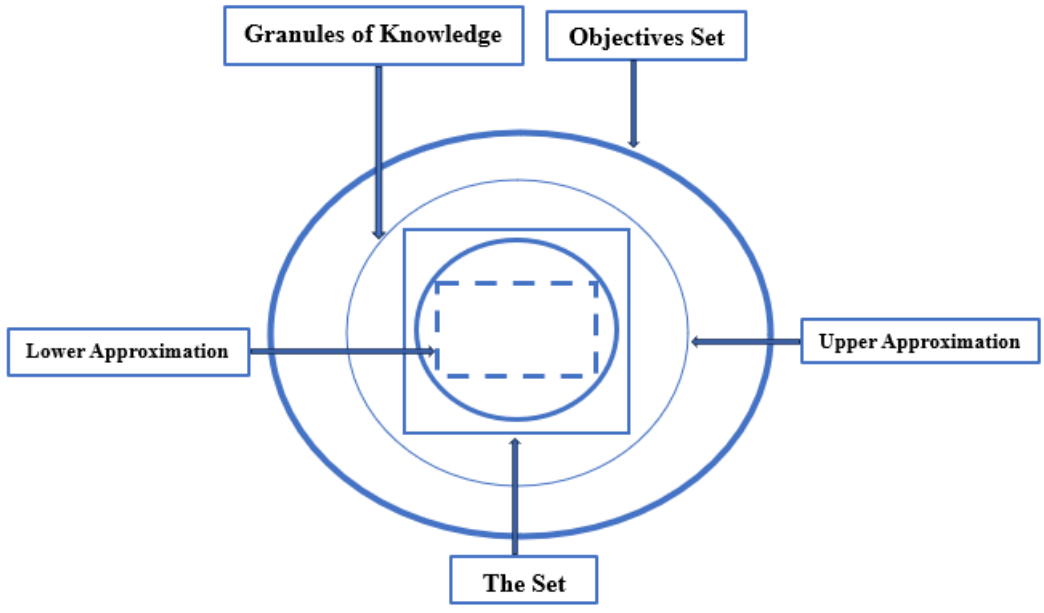

Figure 1. Characteristics of Lower and Upper Approximations in Rough Set Theory.

Source: Pawlak et al. 1995

Approximation: it is given by two sets, both of which are finite and non-empty, namely set U and set A, where set U is the relative universe and set A is the set of properties (attributes). Attribute a is a subset of set A ($a \in A$) for which the values of each attribute Va can be found, called the "domain of a". Any subset of set B of set A is a Binary Relation I(B) on set U, called the "Indiscernibility Relation" (Campagner et al. 2022).

Decision Rule: Decision rules are represented in a data table, which has two groups of attributes: conditional attributes and decision attributes. Different decision rules are called "Invalid Rules", meaning that the rule cannot classify the data or that the rule conflicts. Other rules are called "Valid Rules", meaning that the rule can classify the data or that the rule does not conflict. Sometimes, a valid decision rule is called a "Definite Rule", and an invalid decision rule is called a "Possible Rule". Therefore, a decision table that contains invalid decision rules is called an "Invalid Table", and in other cases, it is called a "Valid Table" (Jiang et al. 2021). The number of correct rules out of all the rules in a decision table can be used to measure the correctness of the table and is denoted by $\gamma(C, D)$, where set C is the attributes of the condition, and set D is the attributes of the decision. Thus, if $\gamma(C, D) = 1$, then the decision table is correct. Therefore, a decision table can be represented as a set of decision rules for any dependency. Whether it is a whole or a subset, it can be constructed to form a set of decision rules that find the dependencies (Guo et al. 2022).

The studies related to the digital business sustainability of Thai SMEs were inconspicuous. However, existing research tends to neglect the special challenges that providers of small and medium enterprises alone encounter in unstable digital conditions, specifically within the setting of a developing country like Thailand. Additionally, the integration of rough set theory with expert consensus techniques, such as the Delphi technique, has not been used very often in this

field to bridge the gap in practical approaches to complex intervals of expert opinion and decision criteria for sustainable business practices. This study aims to fill the gap by thoroughly investigating the structural equation model of digital business sustainability in Thai SMEs using the e-Rough Set Delphi technique. The contribution of this research is to determine and assess the main factors that influence digital sustainability to create strategies for improving SMEs' resiliency and adaptability in Thailand's digital economy. Finally, this study is intended to enrich the theoretical contributions and provide practical solutions for implementing sustainable business practices in the world of SMEs.

Literature Review

1. Basic definition of rough set theory

Decision Table: Determined table as an information system consisting of, the set of U, A, V, and f denoted by T = (U, A = C ∪ D, V, f), such that $C \cap D = \phi$ where U is a finite and non-empty set called the universe, denoted by U = {x_1, x_2, … , x_i }, and the members of the universe are called objects, and i is the number of objects. C is the set of conditional attributes, which it a non-empty set, denoted by C = {a_1, a_2, … , a_n}, and n is the number of conditional attributes. D is the set of decision attributes. which is a finite set and not equal to the empty set, denoted by D = {d_1, d_2, … , d_m}, and m is the number of decision attributes. V is the domain value of each attribute A, denoted by $V = \cup_{P \in A} V_P$, where V_P is the domain value of attribute p and f is a function between the relative universe U and attribute A, corresponding to the domain value of attribute V, denoted by $f : U \times A \rightarrow V$, where $f(x_i , q)$ is a function between object i and attribute q for every $q \in A$ and $xi \in U$. Example of decision table consider the decision table by setting Suitable, Possible as condition attributes (Zhao et al. 2023; Zhang et al. 2022), and Decision as decision attributes. According to Definition 1, explained in Table 1.

Expert	Attribute		
	Suitable (a_1)	Possible (a_2)	Decision
x_1	Very Much	Very Much	Agree
x_2	Very Low	Very Much	Disagree
x_3	Much	Very Much	Agree
x_4	Neutral	Neutral	Disagree
x_5	Neutral	Very Low	Disagree
x_6	Much	Very Much	Agree
x_7	Much	Much	Agree
x_8	Neutral	Low	Disagree
x_9	Very Much	Very Much	Agree
x_{10}	Very Much	Much	Agree
x_{11}	Very Much	Very Much	Agree
x_{12}	Very Much	Very Much	Agree
x_{13}	Very Much	Much	Agree
x_{14}	Very Much	Much	Agree
x_{15}	Very Much	Very Much	Agree
x_{16}	Very Much	Low	Disagree
x_{17}	Low	Low	Disagree

Table 1. Decision Table of Expert Opinion Based on Rough Set Theory.

Source: Pawlak, 1997, p.48

Indiscernibility Relation: Define P as a subset of an attribute A, denoted by $P \subseteq A$. Objects i and j are members of the relative universe, denoted by $x_i, x_j \in U$. The invisibility relation of the attribute set P, denoted by IND(P), is known that the set of objects of the relative universe, those two objects have the same domain of the attribute set P. An example of an invisibility relation is presented in Table 1 (Zhang et al. 2022).

Lower Approximation: Defined R as a subset of the attribute C, denoted by $R \subseteq C$, and X be a subset of the relative universe, denoted by $X \subseteq U$, then the lower bound approximation of the object X satisfies the attribute set R, denoted by RX, is the set of all objects of the relative universe that can be exactly individuated by the value of the decision attribute, satisfies the value of the attribute set R (El-Bably et al. 2021).

Positive Area: The positive area of decision attribute D corresponds to the attribute set R, denoted POSR(D), and is all objects that can be exactly indivisible into classes based on their domain attribute values. All possible decisions correspond to the attribute set R (Sahu et al. 2021).

Discernibility Matrix and Discernibility Function: The discernibility matrix M(T) of a decision table $T = (U, C \cup D, V, f)$ is the decision table matrix $\lceil U \rceil x \lceil U \rceil$, where m_{ij} is the set of all attributes that can distinguish between object i and object j of different decision classes in U/IND(D) (Huang et al. 2022).

Dependency of Attribute: Defined $C, D \subseteq A$ as the decision attribute (D) depends on the conditional attribute (C) of degree k, $(0 \leq k \leq 1)$. In the search for trap attributes, more than one trap set may be found, and naturally, no one knows which is the optimal set, so there must be a way to select the optimal set to reduce the experiment time and get accurate results (Patra et al. 2021).

Delphi Definition: Karimi et al. (2022), stated that the Delphi technique is used to predict possible future situations. It aims to minimize the influence of individuals in cases of confrontation while also reducing the impact of differing expert opinions. Yet, the Delphi technique is a means of obtaining a consistent statement regarding a study of which the non-experts do not control the answers. As explained by Pratama et al. (2023), the Delphi technique is a decision-making method designed to fill the gap of conventional methods that depend on one expert's initial opinion, a group of interested people, or consensus. Khosravi et al. (2024) states that the Delphi technique is a structured process of asking questions to participants in which participants respond to questionnaires and provide information and opinions. Thus, it aims to collect expert judgments and consensus on future possibilities in terms of timing, scale, or desired outcomes. Qiu et al. (2021) mentioned that a systematic review of the topic or issue is conducted through a structured set of questionnaires and analyzing the summarized feedback. As stated by Moheimani et al. (2021), the project is structured, involving administering questionnaires on different matters for the purpose of feedback and opinions to gather judgments and build consensus on future possibilities. As discussed by Kang (2021), it is a technique of decision-making considerations that aims to solve the problem of traditional decision-making, which is based on the opinion of a single expert, a group, or the resolution of a meeting. In conclusion, the Delphi method involves collecting the opinions of several experts or qualified persons on a number of issues about the future in their areas of interest and consolidating these

opinions into a common point of view while using questionnaires to provide insight for professionals.

2. Key Features of the Delphi Method

There are two fundamental assumptions underpinning the Delphi technique. The first point is that a group tends to make better decisions than a single person, especially better decisions than a single person who is an expert on the matter in question. The second assumption is that group decisions result in higher accuracy, particularly when the interaction among members is non-confrontational to minimize bias and promote more objective consultation. The efficacy of the Delphi method as one of the tools that harness collective intelligence to arrive at well-informed conclusions is predicated on these assumptions. The important characteristic of the Delphi technique is that anonymity is achieved by using questionnaires so that participants do not have to confront each other and are unaware of who provided each comment. This allows them to focus on the value of the comment without being influenced by the position or persuasive ability of the commenter. Participants who express differing opinions do not feel pressured by those with higher qualifications or by the majority opinion (Ismail et al. 2023). Iteration is achieved by distributing the same questionnaire multiple times, allowing respondents to reconsider their opinions based on the perspectives and reasoning of others without fear of losing face. Controlled feedback involves refining and summarizing the group's opinions before presenting them to respondents in the next rounds. Participants are informed of the overall responses, including criticisms, suggestions, and the rationale behind both agreeing and disagreeing viewpoints. The presentation of the statistical group response is an essential part of the feedback process between each round of the questionnaire, normally showing the group response as the median along with the level of opinion distribution. The electronic Delphi technique (Cuhls, 2023) integrates electronic research methods with the Delphi technique to synthesize expert opinions, to predict trends in various issues for planning and management purposes. Nowadays, this method is popularly applied across numerous fields, including business, politics, military, economics, health, and education, providing expert-driven insights for decision-making and trend analysis. The electronic Delphi technique concentrates on gathering opinions and suggestions, requiring researchers to develop structured tools for effective management, enhances the Delphi method by using the Internet and e-mail for communication instead of traditional paper-based questionnaires, facilitating a more efficient and paperless approach to expert surveys (Spranger et al. 2022; Harteis, 2022).

There are several other features that characterize the Delphi technique. First, it is non-directive and open-ended, which indicates that the participants have the freedom to express their thoughts for as long as they want without any type of guidance. Secondly, the research employs a semi-structured interview format where predetermined topics or questions are used to elicit the experts' opinions and suggestions through a carefully designed survey. Third, the method summarizes and reflects the responses of participants through a cumulative activity and makes systematic application of the method through collecting and organizing responses. Also, analysis and synthesis are fundamental in achieving consensus among the experts by collating different views. The last point made by this component is about writing for the future, that is, writing ideas and solutions that are feasible and tangible enough for future problems.

Research Objectives

The aim of this study is to examine the consistency of the confirmatory factor analysis (CFA) model of digital business sustainability among SMEs in Thailand. It is intended to evaluate how

well the model aligns with the observed data to gain insight into the relationships of key influencing factors on digital business sustainability. Through rigorous testing of the model, the research aims not only to validate the robustness of the model but also to identify areas for improvement and further exploration. The implications of this analysis would contribute to the understanding of the dynamics of digital business practices in Thai SMEs and provide guidance for strategically enhancing business sustainability within the digital economy.

Methods

This research analyzes the relevant variables affecting digital business sustainability among SMEs in Thailand using the e-Rough Set Delphi technique, first conducting first-order confirmatory factor analysis, and then second-order confirmatory factor analysis. Using a mixed methods approach, this study combines qualitative and quantitative data collection and analysis to ensure a comprehensive examination of the digital business sustainability model. The research systematically validate the CFA of digital business sustainability model tailored to the specific context of Thai SMEs through the utilization of the e-Rough Set Delphi technique. The process involves several steps to effectively capture the dynamics of digital business practices and their implications for sustainability, providing valuable insights to stakeholders in the region. This study has reviewed and approved by The Office of Research Ethics at Rangsit University, COA. No. RSUERB2024-017.

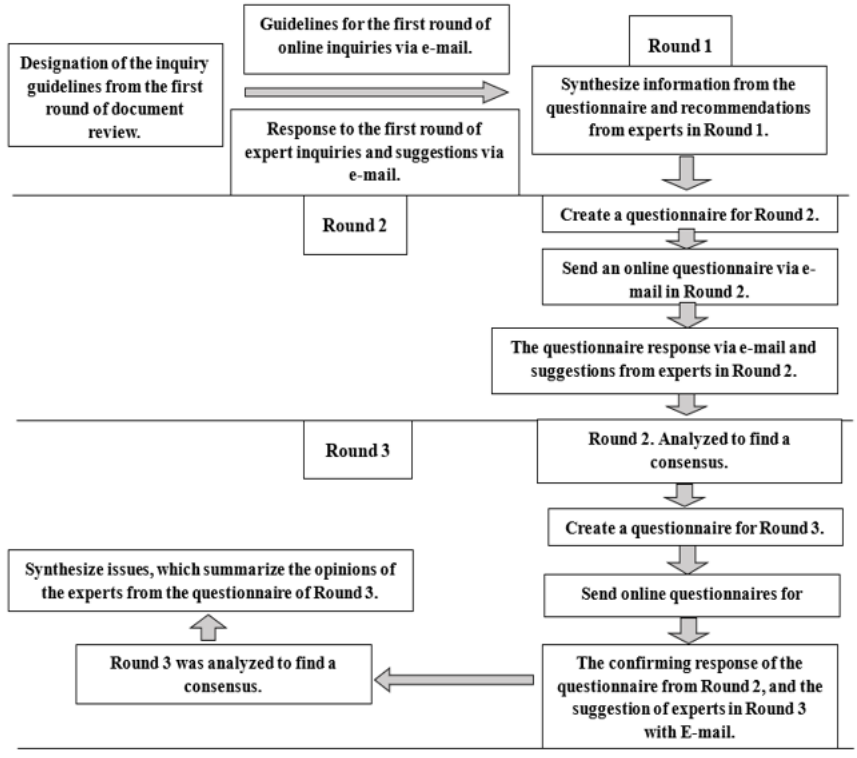

Figure 2: The Conceptual Framework of the e-Rough Set Delphi Technique Procedure

Figure 2 explains the steps involved in developing CFA of digital business sustainability among SMEs in Thailand using the e-Rough Set Delphi Technique. The process details are as follows:

Round 1: Synthesized the data from the inquiry guidelines and expert recommendations using an open-ended questionnaire which is designed to comprehensive issues under study and conduct optimal results, sending questionnaires via email to all 20 experts to collect data.

Round 2: A rating-scale questionnaire is developed based on the responses from all 20 experts in Round 1. Experts' opinions are consolidated, duplicate data is removed, and a refined questionnaire is created. The same experts then reassess the questionnaire using a 7-point Likert scale. Data collection is again conducted via e-mail.

Round 3: The questionnaire in this round was created using a 7-point Linkert scale and the e-Rough Set Delphi technique. If the QL value is less than 0.75, it indicates an inconsistency in opinions, while a QL value greater than 0.75 signifies consensus among experts.

Population and Samples

This research involves a varied population that influences data analysis across multiple sectors. The researchers categorized the participants into three groups: Group 1 consists of seven experts from government sector representatives related to entrepreneurship, Group 2 includes six university lecturers specializing in entrepreneurship development, and Group 3 with seven successful digital business entrepreneurs from SMEs, totaling 20 experts in all groups.

Group 1: Government sector representatives related to entrepreneurship. The selection criteria for the seven experts in this group include possessing knowledge and understanding of SMEs entrepreneurship. The experts must currently work or have previously worked in organizations related to online businesses for SMEs.

Group 2: University lecturers in SMEs development. The six experts in this group were selected based on the criteria which must be university lecturers with knowledge and expertise in SMEs entrepreneurship development and have at least three years of experience in the field.

Group 3: SME entrepreneurs with more than five years of experience. The seven experts in this group were selected based on the criteria that they must be successful SME entrepreneurs, demonstrate profitability, and have at least five years of experience as entrepreneurs.

Research Tools

The primary tool used for collecting data in this research was an online questionnaire to develop a CFA model for digital business sustainability in SMEs in Thailand. The researcher reviewed various other related studies and compiled pertinent data to ensure the relevance and rigor of the questionnaire. Two formats of the questionnaire were used: an open-ended questionnaire and a 7-point Likert scale questionnaire. These questionnaires were distributed to 20 experts in three rounds. In the first round, information was synthesized from the responses and expert recommendations by designing an open-ended online questionnaire using Google Forms with 10 questions to gather initial insights. In the second round, a structured questionnaire with a 7-point Likert scale was used to rate the development of the digital business sustainability model. This revised questionnaire was completed by the same 20 experts through Google Forms. In the third round, a questionnaire based on a 7-point Likert scale was used. This version maintained the same indicators as in the second round, incorporating feedback and presenting consensus

measurement results and responses from each expert. The analysis of the second round confirmed or revised the experts' answers, validating and revalidating the findings.

Data Collection

The data was collected by sending an e-mail based online questionnaire to the participants from January to March 2024, over three rounds, each lasting three months.

Data Analysis

The researcher used e-Rough Set Delphi theory in the data analysis of this research. The new mathematical method in Rough Set Theory is concerned with sets and their members, not definite. It can extract the boundaries or lower/upper bounds of data groups to assess the ambiguity and uncertainty of data. This theory can be used to consider the decisions of experts using Decision Rules as follows:

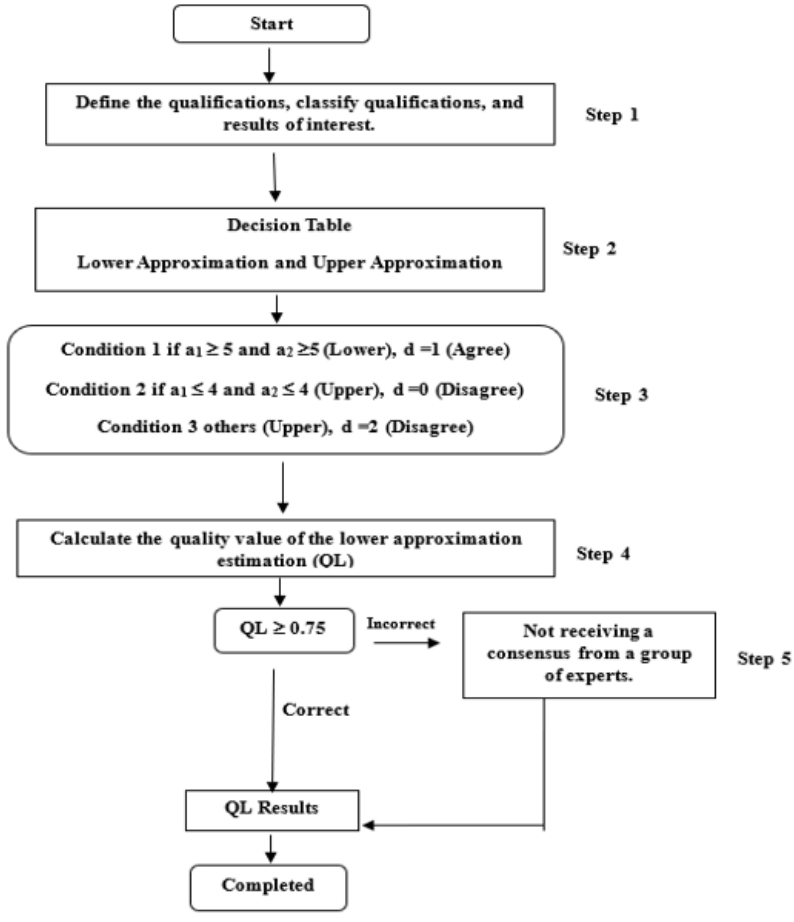

Figure 3: Diagram of Expert Group Consensus Measurement Using the Rough Set Theory.

For this research, the main tool used to collect the data was an online questionnaire to build a digital business sustainability model of SMEs in Thailand. To keep the questionnaire relevant

and the data rigorous, the researcher looked at various other related studies and compiled the pertinent data. A questionnaire was distributed to 20 experts in two different formats: an open-ended questionnaire and a 7-point Likert scale questionnaire, over three rounds. In the first round, information synthesized from responses and expert recommendations was loaded in the form of an open-ended online questionnaire created in Google Forms with 10 questions to gain initial insights. Based on the responses in round 1, a structured questionnaire was developed to score the Round 2 development of the digital business sustainability model with a 7-point Likert scale. This questionnaire was revised through Google Forms, and the same 20 experts were invited to complete it. In Round 3, an additional questionnaire based on a 7-point Likert scale was designed, continuing the same indicators from Round 2 but adding feedback and consensus measurement results with each expert's responses. This approach allowed the study experts to confirm or amend their answers based on the analysis of Round 2, helping to validate and ensure the reliability of the findings. Figure 3 presents the steps for the consensus measurement of an expert group using Rough Set Theory. The process consists of five steps. The first step is to determine the character of the subject by the desired characteristics, features, and feel. In Step 2, a decision table is created grouping the results into two sets of entirely different data: lower approximation and upper approximation. In Step 3, for each expert, decision rules (d) are defined according to Rough Set Theory based on three specific conditions. Step 4 involves calculating the quality of the lower approximation by dividing the number of experts who agree on a question (forming the upper approximation) by the total number of experts consulted. Step 5 focuses on determining the criteria for measuring the consensus of the expert group, primarily in terms of the quality of the lower approximation (QL). This step establishes two criteria further detailed in Table 2.

Consensus measurement	**Criteria**
Quality of estimation. Lower approximation (QL)	QL < 0.75 No consensus was reached from the expert group.
	QL ≥ 0.75 Obtained consensus from a group of experts.

Table 2. Criteria For Measuring Consensus of Expert Groups Using the Rough Set Theory.

Delphi Technique Research Procedure

The Delphi technique research process involves the following steps:

1) Define the research problem: Choose a problem without a definitive answer that can benefit from expert opinions for decision-making in policy planning or future predictions.

2) Select the expert group: Ensure the reliability of results by choosing a group of experts based on their expertise, trustworthiness, cooperation, and selection method. Studies typically use 17 or more experts to minimize error rates and ensure a diverse range of perspectives. Homogeneity within the expert group is also important (Shang, 2023). Therefore, it is common to use 17 or more experts, though the homogeneity of the expert group is also a key consideration (Nasa et al. 2021).

3) Expert opinion collection process: Experts are asked to complete questionnaires in up to three rounds. The process involves:

3.1) First round questionnaires: Open-ended questions are sent to experts to gather opinions on research topics. Questionnaires are mailed with a deadline of two weeks for completion. Responses are analyzed to eliminate repetitive content and inform the next round.

3.2) Second round questionnaires: Based on first round responses, a 7-point Likert scale questionnaire is created for experts to rate and provide feedback on each item. Responses are analyzed using median and interquartile range calculations.

3.3) Third round analysis: Responses from the second round are analyzed to determine consensus among experts. If consensus is reached, research results can be concluded. If not, further steps may be taken to address inconsistencies (Drumm et al. 2022).

4) Summarizing results and preparing a report: This step involves consolidating the experts' opinions into a coherent summary of findings. The results are compiled into a report for decision-makers to review and act upon.

The Delphi technique involves using questionnaires with open-ended and closed-ended 7-point Likert scales. Open-ended questionnaires gather general opinions from experts in the first round, while closed-end questionnaires prioritize or predict trends based on the initial responses. In subsequent rounds, statistical values are calculated from the experts' answers to provide feedback, such as median, interquartile range, frequency, and percentage. This feedback helps experts understand the consensus within the group. The statistical values include summaries of experts' opinions and distributions, with common statistics like standard deviation and frequency distribution used to show consensus. The Delphi technique typically involves two to three rounds of data collection, continuing until a consensus is reached or consensus cannot be achieved. The number of rounds needed depends on the level of group consensus in each round (Barrios et al. 2021). Niederberger et al. (2021), reviewed the measurement of consensus in the Delphi technique since the 1960s and found that many methods can be divided into two groups: measuring consensus with qualitative analysis and descriptive statistics and measuring consensus with inferential statistics. The review concluded that there is no standard method. Most researchers use subjective criteria, along with descriptive and inferential statistics, to measure the consensus and convergence of expert group opinions.

The consensus is an important prerequisite for the Delphi study process, but consensus criteria are still diverse, and reporting remains incomplete. Therefore, it is necessary to establish standard criteria for reporting studies using the Delphi technique (Bilbro et al. 2021). Moreover, good Delphi research must consider four important issues:

1) Determination of study termination criteria

2) Determination of the number of study rounds,

3) Determination of expert selection criteria, and

4) Determination of dropout criteria for questions in each final round.

The criteria for reporting the Delphi technique (Landeta et al. 2024; Attallah et al. 2022), said that it should cover the following:

1) **Objective of the study**: The objective must be clearly stated, focusing on the consensus of the study issues that reflect the agreement of the group.

2) **Participants or experts**: The inclusion or exclusion criteria for experts must be specified, along with the definition of consensus and the statistical values used for determining the study termination criteria.

3) **The Delphi process** must report the items that were eliminated or removed in each round of the study.

Results

The results of the qualitative research were obtained using the e-Rough Set Delphi technique to evaluate the digital business sustainability for SMEs in Thailand through three rounds of online questionnaires. First, ten items in the open-ended questionnaire were collected to gather expert opinions to gain initial insights into the major components and relevance of the model. In round 2, a closed-ended questionnaire with a 7-point Likert scale was used, where the experts were asked to rate the suitability and possibility of the digital business sustainability model. Moreover, all aspects and questions met the conditions set out by the e-Rough Set Delphi technique, with a QL greater than 0.75. In round 3, the same 20 experts confirmed their opinions from round 2 with a closed-ended questionnaire, and all assessments were made on the model's appropriateness and feasibility, meeting the set criteria and strengthening the consensus created in the previous round.

1. Results of the first-order confirmatory factor analysis model of the digital business sustainability for Thai SMEs are Shown in Figure 4.

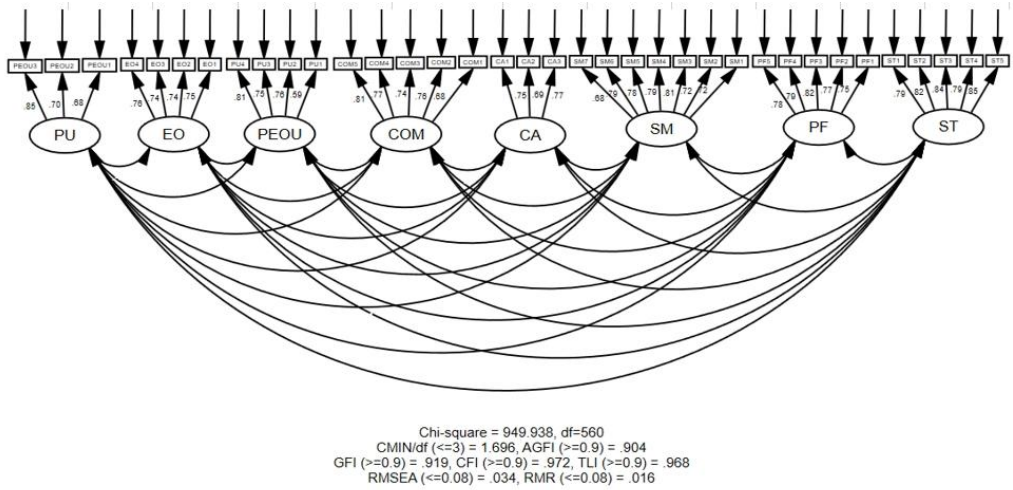

Figure 4: The first-order confirmatory factor analysis model of the digital business sustainability for Thai SMEs.

Figure 4. The results of the test of consistency and harmony of the construct validity by first-order confirmatory factor analysis found that the CMIN/df statistic value was equal to 1.696, the AGFI value was equal to 0.904, the GFI value was equal to 0.919, the CFI value was equal to 0.972, the RMSEA value was equal to 0.034, and the RMR value was equal to 0.016, indicating that the measurement model of all latent variables of the research model was consistent with the empirical data, presented in Table 3.

Index	Measurement	Statistics Gathered	Result
CMIN/df	≤ 3.00	1.696	Fit
RMR	< 0.08	0.016	Fit
RMSEA	< 0.08	0.034	Fit
CFI	≥ 0.90	0.972	Fit
GFI	≥ 0.90	0.919	Fit
AGFI	≥ 0.90	0.904	Fit
TLI	≥ 0.90	0.968	Fit

Table 3. Overall model fit statistics of first-order CFA model

2. Results of second-order confirmatory factor analysis model of the digital business sustainability for Thai SMEs are shown in Figure 5.

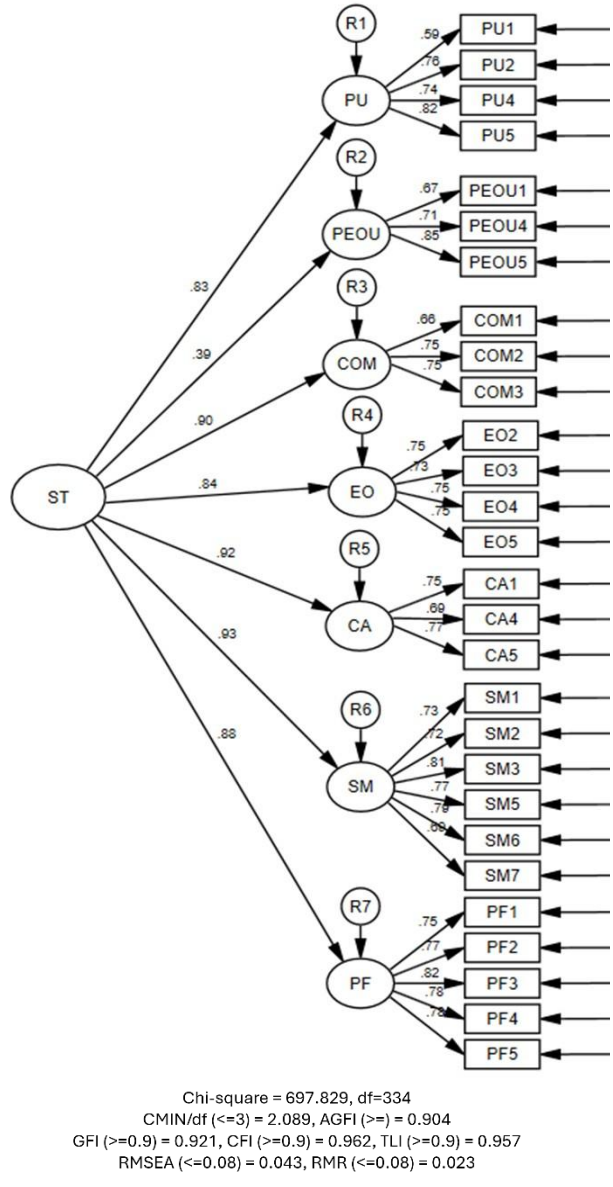

Figure 5: The second-order confirmatory factor analysis model of the digital business sustainability for Thai SMEs

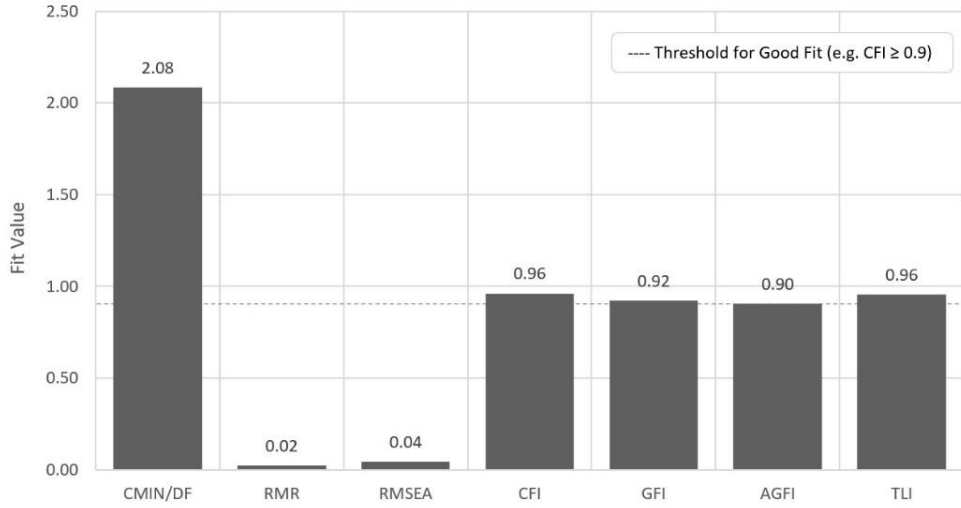

Figure 6: Second-Order Confirmatory Factor Analysis – Model Fit Indices

The second-order confirmatory factor analysis is presented in Figure 6 to assess how well the research model fits overall. Key fit indices of CMIN/df, RMR, RMSEA, CFI, GFI, AGFI, and TLI are shown on the graph, with all values being below acceptable levels. Since error-related indices such as RMR (0.023) and RMSEA (0.043) have minimal residual error (< 0.08) and the CMIN/df value is approximately 2.09, the model fit is considered good (≤ 3.00). The model fit is strong, as indicated by CFI of 0.96, GFI of 0.92, AGFI of 0.90, and TLI of 0.96, all of which meet or exceed the recommended minimum (i.e., ≥ 0.90). Together, these findings support the structural integrity and theoretical soundness of the second-order measurement model, providing support for the creation of broader constructs based on first-order CFA findings.

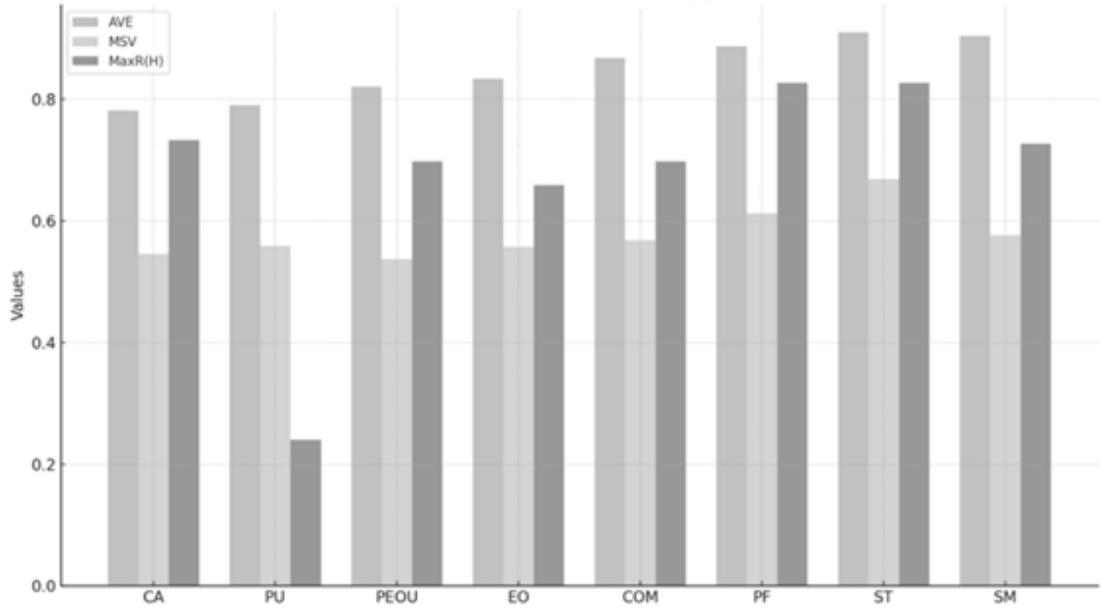

Figure 7: Comparison of AVE, MSV, and MaxR(H) Across Constructs

The Average Variance Extracted (AVE) value, Maximum Shared Variance (MSV) value, and Maximum Reliability (MaxR(H)) value for eight influential constructs such as CA, PU, PEOU, EO, COM, PF, ST, and SM are depicted in Figure 7. Convergent validity for all constructs is high due to the values for AVE for all constructs exceeding 0.78. Finally, discriminant validity is supported by most constructs having an AVE value greater than MSV. MaxR(H) values are in good agreement with AVE, except for PU, which has a lower MaxR(H) value (0.24) that calls for closer scrutiny. Overall, this supports the measurement model's validity and reliability.

Index	**Measurement**	**Statistics gathered**	**Result**
CMIN/df	≤ 3.00	2.089	Fit
RMR	< 0.08	0.023	Fit
RMSEA	< 0.08	0.043	Fit
CFI	≥ 0.90	0.962	Fit
GFI	≥ 0.90	0.921	Fit
AGFI	≥ 0.90	0.904	Fit
TLI	≥ 0.90	0.957	Fit

Table 4. Overall model fit statistics of second-order CFA model

In the second-order confirmatory factor analysis (CFA), the results of the structural validity assessment are shown in Figure 5 and summarized in Table 4. The measurement model was analyzed to test the consistency and reliability of the measurement model using key fit indices. The CMIN/df value of 2.089 is within the acceptable threshold value (≤ 3.00), indicating a good fit, with the df value appropriately equal to CMIN. All additional indices, such as AGFI (0.904), GFI (0.921), and CFI (0.962) exceed the recommended minimum of 0.90, indicating a good model fit. Additionally, error-related indices such as RMSEA (0.043) and RMR (0.023) have values less than the maximum permissible limit of 0.08, indicating minimal error in the model. These results collectively support the structural validity of the research framework. Subsequently, the second-order CFA (Figure 5 and Table 4) validates the overarching construct structure of the research model. Specific statistics for this analysis are yet to be filled in, but it is expected that the fit indices CMIN/df, RMR, RMSEA, CFI, GFI, AGFI, and TLI will fall within acceptable ranges, indicating a good model fit. Once completed, these results will verify the structural integrity and theoretical continuity of the broader constructs and individual measurement items. This layered validation process enhances the credibility of the research model, demonstrating its adequacy for explaining the phenomena under study.

Moreover, the researchers coded the latent and observed variables, as shown in Table 5

Latent Variables	**Observed Variables**	**λ**	**R^2**	**CR**	**AVE**
Perceived Usefulness (PU)	PU1	0.74	0.55	0.84	0.56
	PU2	0.87	0.76		
	PU3	0.64	0.41		
	PU4	0.73	0.53		

Perceived Ease of Use (PEOU)	PEOU1	0.64	0.41	0.78	0.55
	PEOU2	0.69	0.48		
	PEOU3	0.87	0.76		
Compatibility (COM)	COM1	0.70	0.49	0.87	0.57
	COM2	0.76	0.58		
	COM3	0.74	0.54		
	COM4	0.79	0.62		
	COM5	0.80	0.63		
Entrepreneurial Orientation (EO)	EO1	0.82	0.67	0.83	0.55
	EO2	0.87	0.75		
	EO3	0.65	0.42		
	EO4	0.61	0.37		
Competitive Advantage (CA)	CA1	0.69	0.48	0.78	0.55
	CA2	0.72	0.52		
	CA3	0.80	0.64		
Social Media Usage (SM)	SM1	0.73	0.53	0.90	0.57
	SM2	0.71	0.51		
	SM3	0.78	0.61		
	SM4	0.81	0.65		
	SM5	0.79	0.62		
	SM6	0.77	0.60		
	SM7	0.71	0.51		
SMEs' Performance (PF)	PF1	0.77	0.59	0.89	0.62
	PF2	0.78	0.60		
	PF3	0.81	0.66		
	PF4	0.78	0.61		
	PF5	0.78	0.61		
SMEs' sustainability (ST)	ST1	0.79	0.62	0.91	0.67
	ST2	0.82	0.67		
	ST3	0.83	0.69		
	ST4	0.81	0.65		
	ST5	0.84	0.70		

Table 5. Latent and Observed Variables

From Table 5. Analysis of the factor loading, component reliability analysis (CR), average variance extracted (AVE) of Latent and observed variables, with the analysis results as follows:

1. The result of the component reliability analysis (CR) for the latent variable of perceived usefulness is 0.84, exceeding the 0.70 criterion. This indicates that all four variables are internally consistent with one another and suitable for measuring the latent variable. The average variance extracted (AVE) is 0.56, which is above the 0.50 criterion, suggesting that all four observable variables can effectively measure the latent variable.

2. The result of the component reliability analysis (CR) for the latent variable of perceived ease of use is 0.78, surpassing the 0.70 criterion. This indicates that all three variables are internally

consistent with one another and suitable for measuring the latent variable. The average variance extracted (AVE) is 0.55, which is above the 0.50 criterion, suggesting that all three observable variables can effectively measure the latent variable.

3. The result of the component reliability analysis (CR) for the latent variable of compatibility is 0.87, exceeding the 0.70 criterion. This indicates that all five variables are internally consistent with one another and suitable for measuring the latent variable. Additionally, the average variance extracted (AVE) is 0.57, which surpasses the 0.50 criterion, indicating that all five observable variables can effectively measure the latent variable.

4. The result of the component reliability analysis (CR) for the latent variable of entrepreneurial orientation is 0.83, exceeding the 0.70 criterion. This indicates that all four variables are internally consistent and appropriate for measuring the latent variable. Additionally, the average variance extracted (AVE) is 0.55, which is above the 0.50 criterion, indicating that all four observable variables can effectively measure the latent variable.

5. The result of the component reliability analysis (CR) for the latent variable of competitive advantage is 0.78, exceeding the 0.70 criterion. This indicates that all three variables are internally consistent and appropriate for measuring the latent variable. Additionally, the average variance extracted (AVE) is 0.55, which is above the 0.50 criterion, indicating that all three observable variables can effectively measure the latent variable.

6. The result of the component reliability analysis (CR) for the latent variable regarding social media is 0.90, which exceeds the 0.70 criterion, indicating that all seven variables are internally consistent and suitable for measuring the latent variable. The average variance extracted (AVE) is 0.57, surpassing the 0.50 criterion, which signifies that all seven observable variables can be appropriately utilized to measure the latent variable.

7. The result of the component reliability analysis (CR) for the latent variable concerning the performance of SMEs is 0.89, exceeding the 0.70 criterion. The average variance extracted (AVE) is 0.62, exceeding the 0.50 criterion, indicating that all five observable variables can be used effectively to measure the latent variable.

8. The result of the component reliability analysis (CR) for the latent variable about the sustainability of SMEs is 0.91, which is greater than the 0.70 criterion, indicating that all five variables are internally consistent and suitable for measuring the latent variable. The extracted variance average (AVE) value was 0.67, which surpassed the criterion of 0.50, indicating that all five observed variables could be effectively used to measure the latent variable appropriately.

Discussion

The results of examining the consistency of the developed CFA model with the empirical data showed that the model aligned well with the empirical data, with a CMIN statistic value of 1,493.54, degrees of freedom (df) = 334, CMIN/df = 2.09, GFI = 0.92, and RMSEA = 0.04. According to the concepts and theories applied in this study, the consistency between the hypothetical model and the empirical data was tested. The CMIN/df statistics were less than 3.00, the GFI, AGFI, and CFI values were 0.90 or higher, and the RMSEA value was less than 0.08, which aligned with the structural equation model analysis criteria (Schumacker & Lomax, 2010).

1. Sustainability: It has the most direct and significant influence on SMEs' performance. If SMEs perform well, then sustainability will be more achievable. Profits come when operations

are efficient and allow for investment in sustainable projects and innovation. Furthermore, it ensures that stakeholders (customers, investors, and employees) develop trust in the organization, which is key to ensuring the long-term stability of the organization. Better resource usage is central to sustainability, and it contributes to improving current processes by enhancing internal processes to increase efficiency and reduce costs. Strategic planning focusing on continuous development and adjusting development policies and strategies to market changes is crucial for SMEs to compete effectively and respond appropriately to market requirements.

2. SMEs' performance and sustainability are negatively affected by perceived usefulness indirectly and positively significantly, while social use is directly negatively affected by it. This may be due to various factors related to how businesses perceive and utilize technology. Sometimes, what is perceived as a benefit may not necessarily result in the expected outcomes, leading to dissatisfaction or inappropriate resource utilization. For example, if entrepreneurs believe that the use of new technologies may not yield easy or fruitful outcomes, they may hesitate to continue investing. Moreover, misconceptions about the benefits of technology may result in imprecise presence on social media, investing in platforms unrelated to the target customer, and using content that does not align with the brand identity, ultimately impacting the company's business performance and competitiveness. Lack of understanding of the true advantages of digital technologies may also lead to missed opportunities for customer engagement or market expansion. It is important to accurately assess the benefits of technology for SMEs striving to thrive in the digital era. This can be addressed by providing training and education to employees on how to best utilize technology. Additionally, having a well-developed strategy for implementing social media and digital technology can make a company competitive and sustainable in the long term.

3. SMEs' perception of ease of use has a positive indirect influence on SMEs' sustainability and a positive direct influence on social media usage. For that reason, ease of use plays a critical role in getting new technologies adopted in organizations, especially in cases of SMEs which may lack resources or personnel with advanced technological skills. It also encourages users to learn and adapt faster, thus reducing training time and cost. Furthermore, ease of use allows for a high level of collaboration between the company itself and its partner companies. It is also conducive to innovation, as employees perceive less system complexity and are more willing to experiment with new tools.

4. Regardless of the indirect influence it has on SMEs' sustainability and performance, as well as the direct influence on social media usage, compatibility plays a role. This is an important factor for integrating new technologies with existing systems within the organization. If new technology is built in a way that is compatible with current systems, it eliminates cost problems, and the time required to modify the system. Furthermore, it enhances compatibility between teams, allowing for faster and more accurate information sharing and coordination between different teams, which is crucial for maintaining a competitive advantage.

5. Both SMEs' sustainability and performance are indirectly influenced by Entrepreneurial Orientation and directly affected by social media usage. The role of entrepreneurs in business growth in markets with rapidly changing natures lies in their ability to encourage organizations to take risks and explore new opportunities. Organizations with a strong entrepreneurial orientation are better at recognizing and seizing opportunities in unknown territories, enabling them to survive even in the toughest situations. Additionally, this orientation helps create a

corporate culture that fosters innovation and encourages staff engagement in the business development process.

6. SMEs' performances are directly affected by Competitive Advantage. Strong competitive businesses can maintain their positions within the market and outpace competitors. SMEs can develop products or services that better meet customer expectations by leveraging consumer insights and developing strategies based on a deep understanding of the market and relevant customer needs. A strong brand can enhance the product's value in the eyes of consumers, increase brand recognition, and foster brand loyalty. This means that as businesses grow, they retain their existing customers without losing any of them.

7. Social media usage impairs the performance of SMEs. In the digital age, social media has become a crucial platform for organizations to create brand awareness and provide channels for customer communication. Companies use these platforms to market products, answer customer questions, and gather market insights. Social media also facilitates various activities for SMEs, such as online sales and promotions, helping them expand their customer reach and increase sales efficiency.

Conclusion

The e-Rough Set Delphi method and second-order confirmatory factor analysis have been applied for this study to ascertain the degree of digital business sustainability of SMEs in Thailand. The findings confirm a robust digital business sustainability model and determine key factors, including technological readiness, market adaptability, and resource management, that have a significant impact on the sustainability of digital businesses. This sequence of insights highlights the key focus areas that SMEs must prioritize to become more resilient in a fast-changing digital economy and is a valuable guide for those in the practice and policy of entrepreneurship creation. This research is significant, as the validated model can serve as a guide to enable initiatives that aim at enhancing SMEs capabilities in the digital space. These findings may also contribute to the development of training programs tailored to the needs of entrepreneurs, specifically in relation to their thinking abilities as they deal with the digital realm. Future studies should explore digital business sustainability in broader geographic contexts and long-term trends through longitudinal research, as well as conduct qualitative interviews with entrepreneurs to gain fresh insights into the dynamics of digital business sustainability under different environments.

Limitations

The reliance on expert’s opinions in the qualitative phase may introduce subjectivity. However, efforts to achieve consensus through multiple rounds of data collection.

Recommendations

To enhance SMEs sustainability, businesses should effectively use social media for networking, marketing, and customer engagement to improve performance and long-term stability. Developing competitive advantages through various products or services and adding value will create opportunities for sustained market competition. In addition, improving operational efficiency through continuous performance evaluation and process refinement is crucial for long-term growth. Moreover, further research should explore other sustainability factors, such as technological advancements, human resource development, and adaptation to changing business environments, to ensure SMEs remain resilient and competitive.

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