

The Impact of Digital Transformation an Empirical Analysis on the Stability of Agro-Food SMEs

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Abstract: *As digital tools have become important components for sustaining competitiveness, this research investigated how digital technology knowledge, digital skills, digital usage, and digital adaptation contribute to the stability of agro-food SMEs in Kuala Nerus, Malaysia. SMEs in the agro-food sector recognize the value of digitalization, but many also experience ongoing challenges to integrate digital solutions for operations. In particular, due to limited digital knowledge, a lack of technical skills, and un-reliable usage, many businesses are not achieved their initial intended benefits of digital tools to enhance performance and reach sustainable growth. This study adopts a quantitative approach involving survey data from owners and managers of SMEs to investigate how each digital factor relates to SME stability. Overall, the results showed that SMEs with a greater knowledge of digital tools' capabilities and practical skills tended to improve digital usage leading to greater digital adaptation for business processes. Having capabilities to implement and change business processes accordingly, improved an SME's overall stability by leading to improved supply chain management, greater market presence, and better reactions to changing market conditions. Therefore, the findings emphasize the need to develop technical capabilities as well as a supportive organizational culture for developing digital transformation. It is clear these findings illustrate both the capabilities of businesses and, just as importantly, the organizational culture that accompanies them, and its role in terms of digital transformation. As indicated in our research, it is important that policy makers and support agencies pursue actionable recommendations, for example targeted training programs, incentives, and awareness, to assist agro-food SMEs in moving towards greater digital capabilities and resilience. Furthermore, our analysis of knowledge, skills, use, and adaptation at the same time provides valuable insights about leveraging digital transformation and SME stability for sustainable growth in Malaysia. Information from this project also adds to the discussion on digitalisation as it relates to SMEs while laying, the groundwork for future research and practice aspects.*

Keywords: Agro-food, Digitalisation, Knowledge, Skills, Usage, Stability

1. Introduction

The accelerating pace of digital innovation continues to reshape the competitive landscape of economies worldwide. Digital transformation, defined as the comprehensive adoption of digital technologies across all levels of business operations, has emerged as an indispensable tool for improving efficiency, enabling innovation, and enhancing organizational resilience. In today's volatile and interconnected global environment, this shift is particularly significant for small and medium-sized enterprises (SMEs), which account for over 90 percent of businesses globally and contribute substantially to employment and economic output (Wang et al., 2022). As global markets become increasingly digitized, SMEs are under rising pressure to adapt and transform their operational models to remain viable and sustainable. However, the path toward digital transformation is neither uniform nor equitable. SMEs in rural or semi-urban regions, particularly in the agro-food sector, often lag behind their urban counterparts due to structural constraints, limited infrastructure, digital illiteracy, and insufficient institutional support. These gaps hinder their capacity to fully engage with the digital economy and, consequently, threaten their long-term stability and competitiveness (Al-Okaily et al., 2022).

Across the world, the strategic application of digital technologies among SMEs is recognized as a vital enabler of resilience and innovation. Research shows that digitally advanced SMEs are more likely to survive external shocks such as pandemics and economic crises by leveraging digital marketing, supply chain analytics, online distribution, and remote working tools (Nguyen et al., 2023; Troise & Tani, 2022). The COVID-19 pandemic has accelerated this realization, exposing digital inequalities across sectors and regions. SMEs that lacked access to digital infrastructure or skills suffered disproportionate setbacks in maintaining operations, customer relationships, and workforce coordination (Jonathan et al., 2023). In contrast, businesses that embraced digital tools such as cloud computing, e-commerce platforms, and mobile financial services showed enhanced adaptability, often emerging more resilient post-crisis (Akpan et al., 2022). These findings reaffirm that digital transformation is not merely a technological transition but a strategic imperative that directly impacts SME stability.

In the Malaysian context, SMEs represent a key engine of economic development, contributing over 38 percent to the national GDP and employing nearly half of the country's workforce (Ismail et al., 2022). The government has prioritized the digitalization of SMEs through initiatives such as the Malaysia Digital Economy Blueprint (MyDIGITAL), the SME Digitalisation Grant, and strategic partnerships with private tech providers. However, the outcomes of these initiatives have not been evenly distributed across sectors and regions. Agro-food SMEs, especially those located in rural areas such as Kuala Nerus in Terengganu, continue to experience limited integration of digital technologies. Structural barriers, including poor internet connectivity, low technological awareness, and resistance to change, constrain their ability to engage meaningfully in digital transformation (Salleh et al., 2023). Moreover, the nature of agro-food production, which involves complex supply chains, perishable goods, and informal market structures, demands tailored digital solutions and capacity-building programs that are often lacking in policy implementation (Tan et al., 2022).

Existing literature has consistently highlighted several internal factors that influence digital transformation among SMEs. These include digital literacy, digital knowledge, digital skills, and actual digital usage (Del Giudice et al., 2021). Digital literacy encompasses the ability to locate, evaluate, and effectively use digital tools and platforms, while digital knowledge refers to a deeper understanding of how digital systems function and can be strategically applied in

business contexts (Hernández-Lara et al., 2021). Digital skills involve the technical and operational capabilities required to manage and maintain digital solutions, whereas digital usage represents the extent to which these tools are actively incorporated into daily operations (Ghobakhloo, 2022). Collectively, these dimensions form the foundation of a firm's digital readiness, which in turn influences its adaptability, customer responsiveness, and stability in the face of disruption. However, most empirical studies examine these variables in isolation, often neglecting the interconnectedness of these capabilities and their collective impact on SME resilience, especially in the agro-food sector (Ali et al., 2021).

Within agro-food SMEs, digital tools can significantly streamline operations and enhance traceability, efficiency, and market accessibility. Mobile applications, automated inventory systems, blockchain for supply chain management, and digital marketplaces are transforming traditional business models and creating new growth opportunities (Ferreira et al., 2022). However, many rural agropreneurs remain unaware of or unskilled in using these technologies. A study by Rahman et al. (2022) found that fewer than 30 percent of rural SMEs in Terengganu actively used digital platforms to manage business operations. Even among those aware of digital tools, actual usage remained low due to concerns over cost, security, complexity, and insufficient training. These findings highlight a significant gap between awareness and implementation, underscoring the importance of digital competence beyond mere access to infrastructure (Mustapa et al., 2023). Furthermore, female-led and family-owned agro-businesses face unique barriers, such as digital fear, time constraints, and lack of mentorship, which further widen the digital divide (Yunos et al., 2022).

The case of Kuala Nerus provides a compelling context for analyzing the relationship between digital transformation and SME stability. As a semi-urban district with significant agro-economic activity, Kuala Nerus mirrors the structural challenges faced by rural Malaysia. Although the region has benefited from infrastructure improvements and digital inclusion programs, local SMEs continue to experience low levels of digital integration, limited by both tangible and intangible barriers (Omar et al., 2021). According to recent data from the Ministry of Rural Development, less than 40 percent of SMEs in Kuala Nerus have adopted any form of e-commerce or digital inventory management (MARDI, 2023). This limited uptake is concerning given the strategic importance of the agro-food sector for local livelihoods and food security. Without meaningful digital engagement, these businesses remain vulnerable to market disruptions, climatic shocks, and shifts in consumer behavior.

Several studies have identified that the long-term stability of SMEs depends not only on their ability to withstand economic shocks but also on their capacity to adapt and grow in changing environments (Vial, 2022). Stability in this context is multifaceted, encompassing financial sustainability, operational continuity, customer retention, and strategic adaptability. Digital transformation contributes to all these dimensions by enabling better data-driven decision-making, improving customer engagement, and facilitating access to financial services and markets (Gong & Janssen, 2022). In rural agro-food contexts, digital platforms can also support traceability, compliance with food safety regulations, and the creation of farmer-consumer linkages, thereby increasing transparency and trust. However, digital transformation is not a linear process. It requires a conducive ecosystem involving training institutions, policy support, peer networks, and leadership commitment (Tajudeen et al., 2023).

Despite the increasing recognition of these dynamics, significant research gaps remain. Much of the literature on digital transformation focuses on urban, tech-based SMEs, with limited attention given to agro-food businesses in rural areas (Agostini et al., 2021). Moreover, few

studies take a holistic view of digital readiness by simultaneously evaluating literacy, knowledge, skills, and usage. Even fewer analyze how these dimensions jointly influence SME stability. This study addresses these gaps by providing an empirical analysis of agro-food SMEs in Kuala Nerus, examining the extent to which digital transformation, operationalized through four dimensions, affects their stability. The study's conceptual framework is grounded in the Technology–Organization–Environment (TOE) theory, which emphasizes the interplay between technological capabilities, organizational resources, and external environments in shaping digital adoption outcomes (Chong et al., 2021). By applying this lens to a rural agro-food setting, the study contributes new insights into how SMEs in resource-constrained environments can leverage digital transformation for sustainable development.

The objectives of this study are threefold. First, it seeks to assess the levels of digital literacy, knowledge, skills, and usage among agro-food SMEs in Kuala Nerus. Second, it aims to evaluate the relationship between each digital dimension and SME stability. Third, it endeavors to provide policy recommendations to enhance digital inclusion and resilience among rural SMEs. The findings are expected to inform targeted interventions, support evidence-based policymaking, and contribute to the broader discourse on inclusive digital transformation. As digitalization continues to shape the contours of economic participation, understanding how rural agropreneurs engage with and benefit from this transformation is essential for fostering equitable and sustainable growth in Malaysia and beyond.

2. Literature Review

In recent years, the growing importance of digital transformation has reshaped how small and medium-sized enterprises maintain competitiveness, efficiency, and long-term survival in an increasingly volatile economic environment. Agro-food SMEs, especially those operating in semi-urban and rural districts like Kuala Nerus, face unique challenges in fully leveraging digital technologies to sustain and grow their businesses. While policy initiatives and technological infrastructure have improved, the real impact of digital transformation depends strongly on how SMEs develop and apply digital technology knowledge, digital technology skills, actual digital technology usage, and a mindset of digital adaptation, all of which contribute significantly to overall SME stability. This section critically reviews existing studies related to each of these key dimensions to highlight current understanding, gaps, and the relevance of these factors in rural agro-food contexts.

2.1 Digital Technology Knowledge

Digital technology knowledge is one of the most fundamental enablers of digital transformation in any business setting. It refers to the depth of understanding an SME owner or manager has about the range of available technologies, their features, how they function, and how they can be strategically matched with business objectives. Recent studies indicate that SMEs with higher levels of digital knowledge are more likely to identify suitable technological tools, assess their cost-benefit balance, and align digital investments with market demands and operational processes.

Ali et al. (2021) emphasise that in the agro-food sector, knowledge is not just about knowing what digital tools exist, but also about understanding how digital solutions can support complex supply chain activities, ensure traceability, and open up new distribution channels. For example, farmers and agropreneurs who understand online sales platforms, digital payment systems, and digital traceability mechanisms are better positioned to comply with modern food safety standards and access premium markets that demand product transparency.

Despite widespread recognition of the importance of digital technology knowledge, gaps remain significant, particularly among rural SMEs. Mustapa et al. (2023) found that many agro-food business owners in Terengganu have only a superficial understanding of digital opportunities, often limited to social media promotion, with little awareness of more advanced tools like cloud accounting, blockchain supply chain applications, or integrated inventory systems. Salleh et al. (2023) argue that lack of exposure, limited contact with technology providers, and insufficient sector-specific training are key reasons for these persistent knowledge gaps.

To address this, some scholars recommend more targeted knowledge-sharing initiatives through local cooperatives, community workshops, and partnerships with agricultural extension services. Ferreira et al. (2022) observed that when agropreneurs receive practical demonstrations and see clear examples of cost savings and efficiency gains, their willingness to deepen their knowledge and consider further digital investments increases substantially.

2.2 Digital Technology Skills

Digital technology skills build upon knowledge but refer specifically to the technical and operational capabilities that allow SME owners and their employees to implement, manage, and maintain digital tools in everyday business activities. Skills range from basic computer use and mobile app navigation to more advanced competencies such as managing an e-commerce storefront, using digital inventory tracking, handling online payments securely, and troubleshooting common technical issues.

Nguyen et al. (2023) point out that even when SME owners are aware of digital tools and their potential, low skill levels often prevent them from using these tools effectively. The lack of confidence in managing digital systems frequently results in underutilisation or abandonment of technological solutions after initial attempts. This issue is particularly common in rural agro-food SMEs, where most employees come from backgrounds with minimal exposure to digital technology in their education or prior work experience.

Rahman et al. (2022) found that while some agropreneurs have basic skills for using social media to communicate with customers, they often lack the more advanced skills needed for digital bookkeeping, analysing sales data, or integrating different software solutions. Omar et al. (2021) explains that in many small agro-businesses, the burden of developing new skills falls entirely on the owner, who may already be overextended by daily operational responsibilities. This limits the time and energy available for learning and skill application.

Some studies suggest that community-based training initiatives, hands-on mentoring, and practical, context-specific modules can help bridge this skill gap. Akpan et al. (2022) noted that SMEs that have invested in upskilling their workforce report higher efficiency, better customer engagement, and more confidence in experimenting with new digital solutions. Improving digital skills also reduces dependence on external consultants or family members, empowering SMEs to be more autonomous and adaptable in responding to technological changes.

2.3 Digital Technology Usage

While knowledge and skills form a strong foundation, actual digital technology usage represents the moment when technology begins to generate value for the SME. Usage refers to how consistently and effectively digital tools are integrated into daily operations. This can include using e-commerce websites to sell products, managing inventory through digital

systems, handling online customer service, automating accounting tasks, or using digital tools to coordinate supply chain partners.

Many researchers highlight that awareness and skills do not automatically translate into regular usage. Gong and Janssen (2022) note that SMEs frequently stop at partial adoption, using digital tools occasionally or for limited tasks, which undermines the potential benefits of digitalisation. Ferreira et al. (2022) argue that the agro-food sector illustrates this usage gap clearly. While many agropreneurs have social media pages or WhatsApp groups for basic promotion, relatively few handles order processing, payment tracking, or delivery coordination through integrated digital platforms.

Mustapa et al. (2023) found that barriers to consistent digital usage include cost concerns, fears of data security breaches, lack of customer trust in online transactions, and resistance to changing familiar manual processes. Rural SMEs in Kuala Nerus are no exception. Salleh et al. (2023) observed that even when agropreneurs receive subsidies for digital tools, they often use them minimally or revert to traditional paper-based systems because they find them easier or more reliable in local contexts.

To increase actual usage, scholars recommend that training programmes combine technical instructions with clear demonstrations of how digital tools can reduce daily workload, save time, or expand profit margins. Practical success stories shared by peers can also reduce scepticism and motivate wider usage. Nguyen et al. (2023) underline that once owners experience the tangible benefits of using technology daily, their commitment to integrating digital tools deepens naturally.

2.4 Small and Medium-sized Enterprises (SMEs) Stability

The end goal of developing digital knowledge, skills, usage, and adaptation is to enhance SME stability. Stability in the context of SMEs generally means the ability to maintain consistent operations, survive economic fluctuations, retain customers, meet market demands, and plan for growth. Gong and Janssen (2022) highlight that stable SMEs are more likely to create jobs, contribute to local economic development, and build resilience against unexpected shocks like pandemics or supply chain disruptions.

Nguyen et al. (2023) argue that digitalisation directly supports stability by providing tools to diversify sales channels, reduce dependency on intermediaries, and respond to customer needs in real-time. In the agro-food sector, digital tools can help monitor inventory, predict demand, manage logistics efficiently, and maintain customer trust through traceability and quality assurance. Ferreira et al. (2022) add that when agropreneurs can prove the origins and handling of their products digitally, they can command higher prices and access new markets.

However, digital investments do not automatically translate into stability if SMEs lack the foundational knowledge, skills, and culture for effective use and adaptation. Salleh et al. (2023) caution that partial or superficial digitalisation can create hidden costs and frustration, draining resources instead of building resilience. For rural agro-food SMEs in Kuala Nerus, ensuring that digital transformation genuinely supports stability requires a balanced approach. Policies and support programmes should focus not only on providing devices and infrastructure but also on continuous upskilling, sector-specific knowledge sharing, and encouraging peer learning within the local business community.

2.5 Research Framework and Hypothesis

The research framework of this study is designed to clarify how key aspects of digital transformation influence the stability of agro-food small and medium-sized enterprises in Kuala Nerus. This framework is built on the Resource-Based View, which highlights those unique internal resources such as digital technology knowledge and digital technology skills help SMEs strengthen their competitiveness and resilience. It also incorporates the Dynamic Capability Theory, which explains how digital adaptation enables firms to reconfigure their routines and strategies to respond effectively to changing environments. Digital technology usage reflects the extent to which SMEs apply their knowledge, skills, and adaptive practices in daily operations. Together, these four factors are positioned as the main predictors of SME stability, which in this context refers to an enterprise's capacity to maintain steady operations, cope with disruptions, and achieve sustainable growth. Figure 1 below depicts the conceptual framework which represents the main variables of this study.

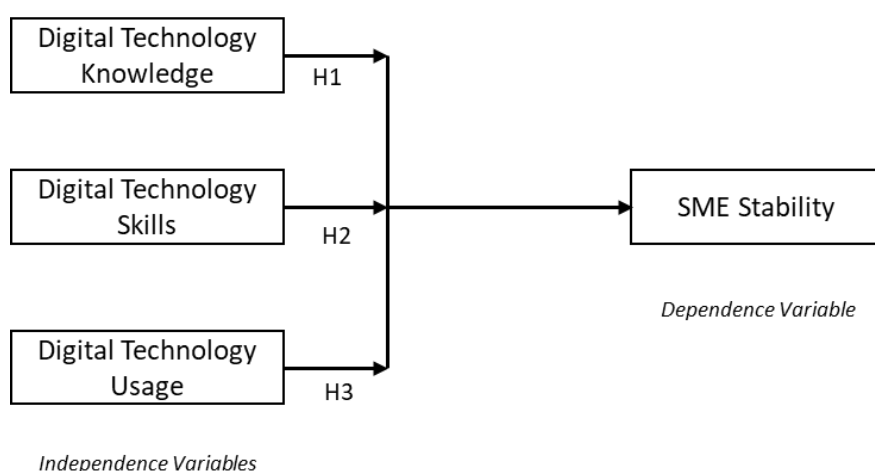


Figure 1: Conceptual Framework

Grounded in these theoretical foundations, this study proposes that digital technology knowledge, skills, usage, and adaptation each have a positive influence on SME stability. The Resource-Based View supports the argument that well-developed digital knowledge and skills give SMEs the capability to manage operations more efficiently and respond to challenges proactively. The Dynamic Capability Theory suggests that when SMEs cultivate the ability to adapt and integrate digital processes into their core activities, they are more likely to remain resilient in a dynamic business environment. In this regard, four hypotheses are formulated to test these assumed relationships empirically. This study looks specifically at the relationships between an independent variable and a dependent variable.

In quantitative research, hypotheses are precise statements that predict the expected relationship between variables. They serve as a foundation for testing theories and guiding data analysis. Typically formulated before the data collection process begins, hypotheses narrow down broad research objectives into specific, testable propositions (Creswell & Creswell, 2018). Quantitative studies emphasize numerical analysis and aim to minimize the influence of human subjectivity, providing objective and replicable results (Saunders, Lewis, & Thornhill, 2019). As noted by Babbie (2020), these studies collect structured data from a sample and use statistical methods to generalize findings to a broader population. Hypotheses are particularly common in experimental designs, where they help determine whether a cause-and-effect relationship exists between independent and dependent variables (McLeod, 2019). Moreover, they play a vital role in establishing the direction and scope of inquiry, ensuring the research remains focused and scientifically rigorous (Bryman, 2021). High-level hypothesis

statements typically identify the central constructs and anticipated associations that form the basis of the research. These hypotheses are summarized in Table 1.

Table 1: Hypotheses have been developed for the construct:

Hypothesis No	Hypothesis Statement
H1	Digital Technology Knowledge is significantly related to SME Stability
H2	Digital Technology Skills is significantly related to SME Stability
H3	Digital Technology Usage is significantly related SME Stability

3. Methodology

This study uses a quantitative research design to examine how digital technology knowledge, digital technology skills, digital technology usage, and digital adaptation influence SME stability. A survey approach is chosen because it allows the researcher to collect numerical data efficiently and test the relationships between variables through statistical analysis. The questionnaire items are adapted from previous studies to make sure the measurements are valid and reliable. All questions use a five-point Likert scale ranging from strongly disagree to strongly agree.

The target group for this research is owners or managers of agro-food SMEs in the Kuala Nerus district. A simple random sampling technique is used to ensure that each SME has an equal chance of being selected. Data are collected through both online surveys and face-to-face distribution to reach businesses that have different levels of internet access. Respondents are informed that their answers will remain confidential and will be used only for academic purposes.

The data gathered are analysed using the Statistical Package for the Social Sciences (SPSS). This method is suitable for testing complex models and examining multiple variables at the same time. Descriptive analysis is used to describe the respondents, while reliability tests such as Cronbach's Alpha check the consistency of the items. The relationships between the variables are then tested to see if the results support the proposed hypotheses.

4. Data Analysis

The data analysis in this study aimed to assess the relationships between digital technology knowledge, digital technology skills, digital technology usage, and SME stability within the context of agro-food SMEs in Kuala Nerus. The analysis employed several statistical techniques, including Reliability Analysis, Correlation Analysis, and Multiple Regression Analysis, all of which are discussed in detail below.

4.1 Reliability Analysis

To assess the internal consistency of the measurement instruments used in this study, Cronbach's Alpha was calculated for each key variable. The reliability coefficients for digital technology knowledge, digital technology skills, digital technology usage, and SME stability were all calculated to determine if the items within each construct were consistent. The results of the reliability analysis are shown in Table 2.

Table 2: Cronbach's Alpha

Variable	Cronbach's Alpha or Alpha Coefficient
Digital Technology Knowledge	0.951
Digital Technology Skills	0.975
Digital Technology Usage	0.939
SME Stability	0.972

The Cronbach's Alpha values for all variables exceed the threshold of 0.70, which indicates that the measurement scales used to assess each construct are highly reliable. Specifically, digital technology skills (0.975) exhibited the highest internal consistency, followed by SME stability (0.972). These high values support the validity of the data and ensure the robustness of subsequent analyses.

4.2 Correlation Analysis

The Pearson correlation analysis was conducted to explore the relationships between digital technology knowledge, digital technology skills, digital technology usage, and SME stability. The results of this analysis, as shown in Table 3, indicate strong, statistically significant positive correlations between the variables.

Table 3: Correlations

Correlations ^b		MEAN_Knowledge	MEAN_Skills	MEAN_Usage	MEAN_Stability
MEAN_Knowledge	Pearson Correlation	1	.871**	.813**	.835**
	Sig. (2-tailed)		.000	.000	.000
MEAN_Skills	Pearson Correlation	.871**	1	.837**	.782**
	Sig. (2-tailed)	.000		.000	.000
MEAN_Usage	Pearson Correlation	.813**	.837**	1	.805**
	Sig. (2-tailed)	.000	.000		.000
MEAN_Stability	Pearson Correlation	.835**	.782**	.805**	1
	Sig. (2-tailed)	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

b. Listwise N=62

All the correlation coefficients are statistically significant at the 0.01 level (2-tailed), as indicated by the double asterisks (**). The strongest correlation was observed between digital technology knowledge and digital skills ($r = 0.871$), suggesting that a higher level of knowledge about digital tools is strongly linked to a greater ability to develop the necessary skills to use these tools. Furthermore, digital usage showed a moderate to strong positive correlation with SME stability ($r = 0.805$), emphasizing the importance of consistently utilizing digital technologies in enhancing the stability of SMEs.

These findings highlight that both the knowledge and usage of digital tools are essential factors contributing to the stability of agro-food SMEs. While digital skills also correlate positively with SME stability, the relationship is slightly weaker ($r = 0.782$), indicating that skill alone may not be as significant without the practical application and usage of digital tools.

4.3 Multiply Regression Analysis

Multiple regression analysis was conducted to assess the combined effect of digital technology knowledge, digital skills, and digital technology usage on SME stability. The results, shown in

Table 4, indicate that the independent variables significantly explain the variance in SME stability, with an R^2 value of 0.745.

Table 4: Model Summary

Model Summary ^b									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.863 ^a	.745	.731	.46445	.745	56.342	3	58	.000

The R^2 value of 0.745 indicates that 74.5% of the variance in SME stability is explained by the combined effects of digital knowledge, digital skills, and digital usage. This suggests that these three factors collectively play a crucial role in determining the stability of SMEs. By improving digital knowledge and usage, SMEs can better adapt to market changes and enhance operational efficiency, ultimately contributing to their long-term resilience. The F-value of 56.342 with a p-value of 0.000 further reinforces the significance of the regression model, showing that the independent variables have a statistically significant impact on SME stability. The results underscore the importance of digital transformation as a key driver of stability and growth for SMEs, particularly in the context of the agro-food sector.

The ANOVA Table for the multiple regression analysis, shown in Table 5, confirms that the regression model is statistically significant, indicating that the independent variables, digital knowledge, digital skills, and digital usage, significantly contribute to explaining the variance in SME stability. The F-value of 56.342 suggests that the model as a whole provides a meaningful explanation of SME stability. The corresponding p-value of 0.000 indicates that the likelihood of the results occurring by chance is virtually zero, confirming the statistical significance of the model.

Table 5: ANOVA for Multiple Regression Analysis

ANOVA ^a						
	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36.461	3	12.154	56.342	.000 ^b
	Residual	12.511	58	.216		
	Total	48.972	61			

The Regression Sum of Squares of 36.461 represents the variance in SME stability that is explained by the independent variables. In contrast, the Residual Sum of Squares of 12.511 represents the portion of the variance in SME stability that remains unexplained by the model. The Mean Square values, calculated by dividing the sum of squares by their respective degrees of freedom, provide a measure of the average variance explained by the model and by the residuals. The F-value of 56.342, derived from the ratio of the Mean Square values, indicates that the model explains a significant portion of the variance in SME stability.

The p-value of 0.000 further supports the conclusion that the model is highly significant, suggesting that the relationship between the independent variables and SME stability is not due to random chance. In summary, the ANOVA results confirm that the regression model, including the variables of digital knowledge, digital skills, and digital usage, is effective in explaining the stability of SMEs in the agro-food sector.

The coefficients from the multiple regression analysis, shown in Table 5, provide valuable insights into how each of the independent variables, namely digital knowledge, digital skills, and digital usage, influences SME stability. The table below presents the unstandardized coefficients, standardized coefficients, t-values, p-values, 95% Confidence Interval for B, and VIF for each variable, all of which help interpret the individual contributions of these predictors to SME stability.

Table 5: Coefficients

Coefficients ^a					
Model		95.0% Confidence Interval for B		Collinearity Statistics	
		Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-.554	.676		
	MEAN_Knowledge	.258	.895	.218	4.588
	MEAN_Skills	-.246	.311	.193	5.188
	MEAN_Usage	.098	.596	.270	3.707

The analysis reveals that digital knowledge has a positive and significant impact on SME stability ($B = 0.577$, $p < 0.001$). This suggests that SMEs with a deeper understanding of digital technologies are more likely to experience greater stability and resilience. As businesses develop a stronger grasp of digital tools, they become better equipped to handle operational challenges and adapt to market changes, which contributes significantly to their long-term stability.

In contrast, digital skills did not demonstrate a statistically significant effect on SME stability ($B = -0.139$, $p = 0.293$). Although digital skills are undeniably important for the effective use of technology, the findings suggest that, in isolation, they do not independently influence SME stability to the same extent as digital knowledge or the actual usage of digital tools. This implies that merely possessing technical skills is not enough to ensure resilience; practical knowledge of how to strategically apply those skills is more critical.

On the other hand, digital usage showed a positive and significant relationship with SME stability ($B = 0.347$, $p = 0.009$). This indicates that SMEs that regularly integrate digital tools into their operations are more likely to maintain stable operations and effectively adapt to external disruptions. Consistent use of digital technologies provides SMEs with the flexibility to respond quickly to changes, enhancing their ability to stay competitive and resilient in dynamic market conditions.

5. Finding

The findings from this study offer important insights into the relationship between digital technology knowledge, digital skills, digital usage, and SME stability within agro-food SMEs in Kuala Nerus.

Firstly, digital knowledge emerged as a significant predictor of SME stability. The unstandardized coefficient for digital knowledge was 0.577, and the p-value was less than 0.001, confirming a strong positive relationship. This result highlights that SMEs with a deeper understanding of digital technologies are more likely to exhibit greater operational resilience. As SMEs develop greater expertise in digital tools and systems, they are better equipped to manage challenges and adapt to market changes, ultimately contributing to their stability.

Secondly, digital skills did not show a significant impact on SME stability. The unstandardized coefficient for digital skills was -0.139, with a p-value of 0.293, indicating that digital skills alone do not directly contribute to SME stability in this context. Although digital skills are essential for utilizing digital tools effectively, the findings suggest that without digital knowledge and practical application, skills alone are insufficient to ensure long-term stability. This points to the importance of not just possessing technical skills but also understanding how to strategically apply them in business operations.

On the other hand, digital usage showed a significant positive effect on SME stability. The unstandardized coefficient for digital usage was 0.347, with a p-value of 0.009, confirming that regular and effective use of digital tools contributes to the stability of SMEs. This finding indicates that SMEs that actively integrate digital solutions into their daily operations, such as e-commerce platforms or digital inventory systems, are more likely to maintain steady operations and adapt to changes in their environment. By leveraging digital tools effectively, SMEs can enhance their flexibility, customer responsiveness, and overall stability. Additionally, the Variance Inflation Factor (VIF) values for all predictors were well below the threshold of 10, confirming that there were no issues with multicollinearity, and the model's results are reliable.

The study reveals that while digital knowledge and digital usage are critical factors in enhancing the stability of SMEs, digital skills alone do not have a direct significant impact on stability. This highlights the importance of a holistic approach to digital transformation that focuses on knowledge development and practical usage rather than just skill acquisition. The findings underscore the necessity for agro-food SMEs in Kuala Nerus to improve both their understanding and application of digital technologies to foster long-term stability and resilience.

6. Recommendation

Based on the findings of this study, several recommendations can be made to enhance the stability of agro-food SMEs in Kuala Nerus through digital transformation. These recommendations aim to address the key factors of digital knowledge, digital skills, and digital usage, ensuring that SMEs are better equipped to thrive in a rapidly digitizing business environment.

6.1 Enhance Digital Knowledge through Targeted Training Programs

The study found that digital knowledge is a significant predictor of SME stability, with SMEs possessing higher levels of digital knowledge showing greater resilience. It is therefore crucial for agro-food SMEs to invest in educational initiatives that increase digital literacy. This can be achieved through targeted training programs aimed at SME owners and employees, with a focus on understanding digital tools and how they can be strategically applied to business operations. Collaborations with technology providers, local cooperatives, and agricultural extension services can play a pivotal role in delivering practical, hands-on demonstrations and workshops (Ferreira et al., 2022). Additionally, governmental and non-governmental organizations should continue to support such initiatives by offering financial incentives or subsidies to offset training costs, particularly for rural SMEs (Salleh et al., 2023).

6.2 Promote the Use of Digital Tools for Daily Operations

The study highlights that digital usage has a positive and significant effect on SME stability, emphasizing the need for agro-food SMEs to actively incorporate digital tools into their daily

operations. Government policies and support programs should focus on incentivizing the adoption of e-commerce platforms, digital inventory management systems, and cloud-based solutions for accounting and communication. SME owners and managers should be encouraged to move beyond basic digital applications, such as social media marketing, and explore more advanced solutions like blockchain for supply chain management and automated systems for inventory and order processing (Akpan et al., 2022). Practical success stories and peer learning could be incorporated into training programs to showcase the tangible benefits of digital tool adoption (Nguyen et al., 2023).

6.3 Improve Digital Skills to Facilitate Effective Usage

Although digital skills did not show a statistically significant effect on SME stability, it remains an essential factor in ensuring that digital tools are used effectively. Skill-building initiatives should be a part of any digital transformation program, with a focus on practical training in digital tool management, data analytics, and cybersecurity. By improving digital skills, SMEs can better utilize the tools they adopt and minimize the risks associated with technological implementation. For instance, training modules can be tailored to the specific needs of agro-food SMEs, covering topics such as digital bookkeeping, online customer engagement, and data-driven decision-making (Rahman et al., 2022). SMEs should be encouraged to integrate these skill development initiatives into their continuous professional development programs to ensure sustained growth and adaptability (Gong & Janssen, 2022).

6.4 Encourage Government and Private Sector Collaboration

To accelerate the digital transformation of agro-food SMEs, it is essential to foster collaboration between the government and private sector. The Malaysia Digital Economy Blueprint (MyDIGITAL) has set the stage for digitalization, but further efforts are needed to ensure that rural SMEs are not left behind. Partnerships with private technology providers can help provide affordable and customized digital solutions tailored to the specific needs of agro-food SMEs (Ismail et al., 2022). These partnerships should also include capacity-building initiatives for SME owners and employees, ensuring they have the necessary tools and knowledge to effectively implement digital solutions.

Moreover, financial support programs such as the SME Digitalisation Grant should be expanded to include more comprehensive digital transformation packages. These packages could cover not only the costs of digital tools but also expenses related to training, skill development, and ongoing technical support (Salleh et al., 2023).

6.5 Foster a Digital Transformation Ecosystem

For successful digital transformation, SMEs need a conducive ecosystem that includes access to digital infrastructure, training institutions, policy support, and peer networks. Government agencies should work closely with educational institutions to offer specialized courses in digital technologies relevant to the agro-food sector. The development of local digital hubs or innovation centers could provide SMEs with the resources and support necessary for continuous learning and innovation (Tajudeen et al., 2023). Additionally, fostering peer-to-peer networks within the agro-food sector can facilitate the exchange of knowledge and best practices, further driving the adoption and effective use of digital technologies (Ali et al., 2021).

7. Conclusion

This study has examined the impact of digital transformation on the stability of agro-food SMEs in Kuala Nerus, focusing on the critical dimensions of digital knowledge, digital skills, and digital usage. The findings indicate that digital knowledge and digital usage are significant contributors to SME stability, while digital skills alone do not show a significant direct effect. These results underscore the importance of fostering a comprehensive approach to digital transformation that goes beyond just acquiring technical skills, but also includes deepening digital knowledge and promoting the effective usage of digital tools.

The positive correlation between digital knowledge and SME stability suggests that increasing awareness and understanding of digital tools equips SME owners and employees to adapt more effectively to market demands, technological advancements, and external disruptions. Likewise, the significant impact of digital usage on SME stability emphasizes the importance of consistently integrating digital technologies into business operations, such as through e-commerce, digital inventory management, and online customer engagement.

However, the lack of a significant relationship between digital skills and SME stability highlights a gap that needs addressing. Although technical skills are important for the operational aspects of digital tools, they are insufficient on their own without a broader understanding of how to strategically apply them in business contexts. Therefore, it is essential to develop both digital skills and digital knowledge concurrently.

The study also points to several challenges that rural agro-food SMEs face, including limited digital infrastructure, lack of exposure to advanced digital tools, and resistance to change. To address these barriers, it is recommended that targeted training programs be implemented, focusing on enhancing both digital knowledge and usage, while also improving digital skills. Moreover, increasing collaboration between the government, private sector, and local communities can provide the support needed to accelerate the digitalization process and foster a conducive environment for SME growth and stability.

The digital transformation represents a vital pathway for enhancing the resilience and long-term viability of agro-food SMEs. By improving digital literacy, ensuring consistent usage of digital tools, and overcoming the challenges that rural businesses face, these SMEs can better position themselves to thrive in an increasingly digital economy. Further research and practical interventions are needed to ensure that rural SMEs, particularly those in the agro-food sector, can fully harness the benefits of digital technologies to achieve sustained growth and stability.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this study.

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