DATA SCIENCE FOR SME MANAGEMENT: AN INTEGRATIVE MODEL OF ERP ADOPTION AND INTERCULTURAL COMPETENCE IN THAILAND

Akkavee Poolsawad[1], Aunchistha Poo-Udom[2]*

[1,2] *Graduate School of Service Innovation and Intercultural Communication, Faculty of Hospitality Industry, Kasetsart University, 73140, Thailand.*

ABSTRACT

Small and Medium-sized Enterprises (SMEs) are pivotal to Thailand's economic sustainability but face significant challenges in leveraging advanced technologies, such as Enterprise Resource Planning (ERP) systems. This study addresses this gap by developing and testing a comprehensive model integrating the Technology-Organization-Environment (TOE) framework, the Technology Acceptance Model (TAM), and, as a key theoretical novelty, Intercultural Communication Competence (ICC). A mixed-methods sequential explanatory design was employed, beginning with qualitative interviews (N=18 SME executives) followed by a quantitative PLS-SEM analysis of survey data (N=450 SME leaders). The findings confirm that technological (relative advantage, compatibility), organizational (led by top management support), and environmental (led by competitive pressure) factors significantly predict adoption intention, with perceived usefulness and ease of use as mediators. Crucially, the study provides strong empirical evidence that Intercultural Communication Competence (ICC) is a significant antecedent to both perceived usefulness and ease of use, highlighting its critical role in bridging communication gaps during complex implementations. This research offers a nuanced, integrated adoption model validated in a non-Western context. It provides actionable implications for SMEs, vendors, and policymakers to foster resilience in a dynamic global economy.

1. INTRODUCTION

1.1. The Strategic Imperative of ERP for Sustainable SMEs

Enterprise Resource Planning (ERP) systems have evolved significantly from their origins in MRP during the 1960s, integrating more organizational functions over time and becoming enablers of organizational resilience and sustainability (Bresfelean et al., 2023; Li, 2023). Their increasing integration with automation and real-time analytics has strengthened their strategic value in supporting sustainability reporting and performance (Dumitru et al., 2023; Barna et al., 2021). This evolved in the 1980s into Manufacturing Resource Planning (MRP II), which integrated financial functions with manufacturing operations. The term "ERP" was coined in the 1990s to signify the expansion of this integrative logic across all enterprise functions, from finance and human resources to supply chain management and customer relations (Kurbel, 2005; Bresfelean et al., 2023). The 21st century has witnessed another paradigm shift with the advent of cloud computing, Artificial Intelligence (AI), and the Internet of Things (IoT). Modern, cloud-based ERP solutions now offer unparalleled scalability, data analytics capabilities, and ecosystem connectivity, moving beyond the enterprise's four walls to facilitate dynamic inter-organizational collaboration (Pentyala, 2022; Pakkirisamy, 2025).

The value proposition of these modern systems extends profoundly into the domain of corporate sustainability. ERP systems play a crucial role in achieving the United Nations Sustainable Development Goals (SDGs) by providing a single source of truth and automating data collection across the entire value chain. For instance, sophisticated inventory and logistics modules enable firms to optimize resource use, minimize waste, and reduce their carbon footprint, thereby directly contributing to SDG 12 (Responsible Consumption and Production). Furthermore, integrated supply chain modules can enhance transparency, enabling companies to monitor labor practices and environmental standards among their suppliers, thus supporting SDG 8 (Decent Work and Economic Growth) and SDG 16 (Peace, Justice, and Strong Institutions) (Yu et al., 2025; Pauliukevičienė & Stankevičienė, 2021; Raman et al., 2024). The concept of "Green ERP" has emerged in the academic literature to describe systems designed to track key environmental performance indicators (e.g., energy consumption and emissions) and generate data for both mandatory and voluntary sustainability reporting. Therefore, for Small and Medium-sized Enterprises (SMEs), which often lack dedicated sustainability departments, a well-implemented ERP system can serve as the technological backbone for building a resilient, efficient, and sustainable business model fit for the challenges of the 21st century.

1.2. The Thai SME Context: Opportunities and Challenges

Small and Medium-sized Enterprises (SMEs) constitute the backbone of the Thai economy, serving as a critical engine for employment, innovation, and social stability. In 2023, Thailand was home to approximately 3.2 million SMEs, representing 99.5% of all business establishments. These enterprises significantly contribute to the national economy, accounting for 38.5% of the Gross Domestic Product (GDP) and providing employment for 13 million people, which represents 71% of the total workforce (Microsoft News, 2025; World Bank, 2025). Therefore, the operational efficiency, sustainability, and technological advancements of these enterprises are of profound national importance and are recognized at the highest levels of government.

National strategic initiatives such as "Thailand 4.0," which aims to transform the country into a value-based and innovation-driven economy, and the development of the Eastern Economic Corridor (EEC) as a hub for advanced industries, place significant pressure on SMEs to modernize and digitalize to remain competitive and integrate into new, high-value supply chains (Lewlomphaisarl et al., 2023; Du, 2024; Wongsansukcharoen & Thaweepaiboonwong, 2023).

Despite this strategic impetus, a considerable portion of Thai SMEs grapple with significant barriers to technological adoption. A recent survey by the Office of Small and Medium Enterprises Promotion (OSMEP) found that 88% of Thai SMEs perceive their production processes as outdated. This technological lag is attributable to a confluence of persistent challenges. Financial constraints are particularly acute; many SMEs struggle to secure long-term loans for intangible assets, such as software implementation, as traditional financial institutions often prefer lending against physical collateral. The labor market presents another hurdle, with a notable "brain drain" of skilled IT professionals from SMEs to larger national and multinational corporations that offer higher salaries and clearer career progression paths (Zhang & U-On, 2024; Chaipairinsiri, 2023; Vandeweyer et al., 2020; Ullah, 2018). Furthermore, cultural factors can play a significant role in organizational resistance to change. The hierarchical nature of some family-owned

businesses and a cultural tendency to avoid confrontation can hinder open communication and collaborative problem-solving, both of which are essential for successful ERP implementation.

Consequently, a palpable tension exists: a strong governmental and economic push for SME digitalization coexists with the inherent complexities of ERP systems and the specific resource and cultural limitations of many SMEs. The evolving post-pandemic economic landscape, marked by supply chain disruptions and persistent global uncertainties, has only accelerated the need for SMEs to enhance their operational resilience. In this context, adopting robust digital tools, such as ERP systems, is not merely an academic interest but an urgent business imperative for survival and growth (Meissonier et al., 2014).

1.3. Problem Statement and Research Gap

While the manifold benefits of ERP systems are widely acknowledged, and Thai SMEs are increasingly inclined to invest in IT infrastructure, the specific confluence of factors that determines the successful adoption of these systems within Thailand's unique national and SME-specific context remains inadequately understood. A significant body of research has applied established theoretical frameworks such as the Technology Acceptance Model (TAM) and the Technology-Organization-Environment (TOE) framework to study technology adoption. However, while powerful, these models often fail to capture the full spectrum of influences in a non-Western, relationship-centric business environment such as Thailand (Vichinrojjarul & Suntrayuth, 2019; Allart, 2015; Meissonier et al., 2014).

This study identifies a critical research gap: the lack of a holistic model that integrates macro-level contextual factors (TOE), micro-level individual user perceptions (TAM), and the crucial, often-overlooked interpersonal communication dynamics. While TOE provides the broad landscape of technological, organizational, and environmental pressures, and TAM explains the cognitive calculus of an individual user, neither framework adequately captures the communicative friction that arises when a Thai SME, with its unique cultural norms and implicit communication styles, must negotiate a high-stakes, complex implementation with a foreign ERP vendor or a team of external consultants. Including Intercultural Communication Competence (ICC) is not merely an additive measure; it is the crucial theoretical bridge to connect organizational strategy with on-the-ground implementation success in a globalized context. This research aims to fill this gap

by developing and empirically testing such an integrated model (Meissonier et al., 2013; Inkaew, 2022; Jumpakate & Hieu, 2019).

1.4. Research Questions and Objectives

This study seeks to address the identified gap by investigating the following primary research questions:
- RQ1: What are the key technological, organizational, environmental, and intercultural communication competence factors influencing Thai SMEs' intention to adopt ERP systems? This question aims to identify the specific antecedents that are most salient within the Thai context (Christiansen et al., 2021).
- RQ2: How do perceived usefulness and ease of use mediate the relationships between these antecedent factors and ERP adoption intention? This question explores how external factors are translated into adoption decisions (Su et al., 2023).

The specific objectives of this research are:
- To identify and validate the constituent components of technological, organizational, environmental, and intercultural communication competence factors that affect ERP adoption decisions within Thai SMEs (Allart, 2015).
- To examine these multifaceted factors' direct and indirect effects on ERP adoption intention, explicitly focusing on the mediating roles of perceived usefulness and ease of use (Habahbeh & Obidat, 2021).
- To develop and test a comprehensive, integrated model that explains and predicts the ERP adoption phenomenon in the Thai SME sector with high explanatory power (Liu & Wang, 2010).
- To derive actionable, evidence-based recommendations for SME managers, ERP vendors, and policymakers to enhance the success rate of ERP adoption initiatives in Thailand (Gessa et al., 2023).

1.5. Significance and Contribution of the Study

This study is poised to make several significant contributions to theory, practice, and policy:
- **Theoretical Contribution:** The research tests and validates an integrated conceptual model that synergistically combines the TOE framework, TAM, and ICC. This offers a more holistic and nuanced understanding of technology adoption, particularly within the context of SMEs in a non-Western, developing economy. The explicit incorporation and empirical validation of ICC as a significant

predictor of core TAM beliefs represents a key novel theoretical advancement. This suggests that communication theory can and should be more formally integrated into technology acceptance research.

- **Practical Contribution:** The study aims to provide evidence-based, actionable insights. For Thai SMEs, these insights can inform better strategic planning and management of ERP adoption projects, moving beyond a purely technical focus. For ERP vendors, the findings can guide the tailoring of their product offerings, marketing strategies, and support services to meet the specific needs of the Thai SME market. For policymakers, the research can inform the design of more effective support initiatives aligned with national economic development strategies (Tongsuksai et al., 2023; Wungcharoen, 2022).

- **Contextual Relevance:** The study specifically addresses the need for a deeper understanding of ERP adoption within the SME segment, which often faces challenges different from those faced by large enterprises. Focusing on the Thai context adds further value by providing insights relevant to a major emerging Southeast Asian economy, potentially applicable to other nations with similar economic and cultural profiles.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. ERP Adoption in Small and Medium-sized Enterprises

The adoption of ERP systems by SMEs is a well-documented but complex field of study. Unlike large enterprises with dedicated IT departments and substantial financial resources, SMEs face unique enablers and inhibitors that shape their adoption trajectory.

- **Critical Success Factors in SME ERP Adoption:** A significant stream of research has focused on identifying the Critical Success Factors (CSFs) for ERP implementation. Law, Chen, and Frew's (2021) meta-analysis synthesized findings from over 100 studies. It confirmed that top management support, clear goals and objectives, and effective project management are the most critical factors. However, they noted that for SMEs, factors such as vendor support and the availability of external consultants play a disproportionately larger role than in large corporations, due to SMEs' limited internal expertise. Our study builds on this by confirming

the importance of these factors (e.g., Top Management Support, Organizational Readiness) and embedding them within a broader predictive model (Leyh, 2014; Bansal & Agarwal, 2015; Salih et al., 2022).

- **Barriers to ERP Adoption in Developing Economies:** Research in developing economies has highlighted distinct barriers. A study by Nguyen et al. (2023) in Vietnam emphasized the challenge of a "digital divide" in employee skills, where many IT-savvy individuals coexist with a larger workforce with limited technological literacy. This creates significant change management hurdles. Our research accounts for these barriers through constructs like Perceived Complexity and Organizational Readiness, but situates them within the specific socio-cultural context of Thailand.

- **Cloud ERP vs. On-Premise for SMEs:** The rise of cloud computing has fundamentally altered the ERP landscape for SMEs. Cloud-based ERP solutions, offered on a Software-as-a-Service (SaaS) model, mitigate the barrier of high upfront capital investment and shift the burden of IT maintenance to the vendor. A study by Shin & Lee (2020) in South Korea found that perceived scalability and lower initial costs were the primary drivers of SMEs' choice of cloud ERP. However, they also found that concerns about data security and vendor lock-in were significant inhibitors. While technology-agnostic, our study acknowledges this trend. Constructs such as Relative Advantage and Perceived Complexity are interpreted in light of the different value propositions that cloud solutions offer compared to on-premises solutions.

2.2. Theoretical Foundations

This study integrates three prominent theoretical frameworks — Technology Acceptance Model (TAM), Technology-Organization-Environment (TOE), and Intercultural Communication Competence (ICC) — to construct a comprehensive model that captures the multifaceted nature of ERP adoption. This integrated approach allows for a multi-level analysis that moves beyond purely technocentric or organocentric views to incorporate individual user perceptions and the critical human element of communication in a diverse, globalized context.

2.2.1. Technology Acceptance Model (TAM)

Proposed by Davis (1989), the Technology Acceptance Model is arguably the most influential and widely cited theory for explaining user

acceptance of information technology. Drawing from the Theory of Reasoned Action, TAM posits that an individual's behavioral intention to use a system is the most direct determinant of actual usage. This intention is, in turn, shaped by two fundamental beliefs:

- **Perceived Usefulness (PU):** Defined as "the degree to which an individual believes that using a particular system would enhance his or her job performance".
- **Perceived Ease of Use (PEOU):** Defined as "the degree to which an individual believes that using a particular system would be free of effort".

A key tenet of the model is that PEOU has a direct, positive influence on PU; a system that is easy to use is more likely to be perceived as applicable. TAM's parsimony and high explanatory power have led to its extensive application and validation across various contexts. However, the model has also faced criticism for its simplicity and its limited attention to social and organizational factors. In response, scholars developed extended models such as TAM2, which incorporated social influence processes (subjective norm, image), and the Unified Theory of Acceptance and Use of Technology (UTAUT), which integrated constructs from eight models. While these extended models offer greater explanatory power, they also lose the parsimony of the original.

This study retains the core TAM constructs (PU, PEOU, Intention) as the central mediating mechanism of the adoption process. We address the limitations of the original TAM not by adding more cognitive constructs, but by embedding the entire model within the broader TOE and ICC frameworks, which serve as the "external variables" that shape these core beliefs. This approach maintains the elegance of TAM's core logic while enriching it with vital contextual and interpersonal factors.

2.2.2. Technology-Organization-Environment (TOE) Framework

Developed by Tornatzky & Fleischer (1990), the TOE framework provides a firm-level perspective on technology adoption, positing that three interacting contexts influence the decision-making process:

- **Technological Context:** This pertains to the characteristics of the technologies available to the firm, both internally and externally. Our study operationalizes this context through three well-established constructs from innovation diffusion theory: Relative Advantage, or the perceived benefits of the ERP over existing systems; Perceived Compatibility, the fit of the ERP with existing organizational values and practices; and Perceived Complexity, the perceived difficulty of

using the system. Past literature has consistently shown that higher relative advantage and compatibility encourage adoption, while higher complexity is a significant barrier (Christiansen et al., 2021).

- **Organizational Context:** This encompasses the characteristics and resources of the firm itself. We examine three key organizational factors. Top Management Support is consistently cited in ERP literature as the most critical success factor, providing strategic direction and necessary resources. Organizational Readiness refers to the availability of financial capital and, crucially, the skilled human capital needed for a successful implementation. Organizational Size is included as it influences a firm's ability to absorb the costs and risks associated with large-scale technology projects (Ram et al., 2015).
- **Environmental Context:** This refers to the external arena in which the firm operates. Drawing on institutional theory, this context can be understood through three pressures. Competitive Pressure represents mimetic pressure, in which firms adopt technologies such as ERP systems to keep pace with or surpass competitors. Partner Pressure, from major customers or suppliers, acts as a coercive pressure, compelling adoption to maintain vital business relationships and supply chain integration. Finally, Government Regulation/Support can be seen as a form of normative pressure, in which government policies, tax incentives, and support programs signal the legitimacy and desirability of digitalization, thereby encouraging adoption (Lutfi, 2020).

2.2.3. Intercultural Communication Competence (ICC)

While TOE and TAM provide a robust foundation, they do not fully capture the critical human interactional dynamics in a globalized business environment. This study introduces Intercultural Communication Competence (ICC) as a novel antecedent to technology acceptance. ICC is a multi-dimensional construct defined as the ability to communicate effectively and appropriately with people from different cultural backgrounds. Drawing on the foundational models of ICC developed by scholars like Byram and Deardorff, this study conceptualizes ICC through four key dimensions:

- **Knowledge:** The cognitive understanding of cultural differences, including values, norms, and communication styles, and awareness of one's cultural lens.

- **Attitude:** The affective dimension, encompassing respect for other cultures, openness to new experiences, and empathy.
- **Skills:** The behavioral capabilities required for effective interaction, such as active listening, adapting communication styles, and managing ambiguity.
- **Awareness:** The meta-cognitive ability to be mindful of one's and others' cultural conditioning during an interaction.

While past IT project management literature frequently cites "effective communication" as a critical success factor, this is often considered a vague, un-theorized concept. This study fills a significant gap by operationalizing communication through the validated, multi-dimensional construct of ICC. We posit that in the context of ERP adoption, which often involves interactions between local SME staff and international vendors or consultants, a higher level of ICC within the SME's leadership will lead to a smoother implementation process, thus enhancing perceptions of both the ERP system's usefulness and its ease of use (Bimenov & Toxanbayeva, 2024; Li, 2024; Madden & Ashby, 2021).

2.3. Conceptual Framework and Hypotheses Development

Based on the integration of TAM, TOE, and ICC, our conceptual framework posits that technological, organizational, environmental, and ICC factors serve as external variables that influence the core TAM constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), which, in turn, affect Adoption Intention. Figure 1 illustrates these hypothesized relationships.

- **Core TAM Hypotheses:**
- H1: Perceived Usefulness (PU) will positively affect the Intention to Adopt ERP.
- H2: Perceived Ease of Use (PEOU) will positively affect the Intention to Adopt ERP.
- H3: Perceived Ease of Use (PEOU) will positively affect Perceived Usefulness (PU).
- **Antecedents to TAM Constructs:**
- H4: Relative Advantage will positively affect (a) PU and (b) PEOU.
- H5: Perceived Compatibility will positively affect (a) PU and (b) PEOU.
- H6: Perceived Complexity will negatively affect PEOU.
- H7: The Organizational Context will positively affect (a) PU and (b) PEOU.
- H8: The Environmental Context will positively affect (a) PU and (b) PEOU.
- H9: Intercultural Communication Competence (ICC) will have a positive effect on (a) PU and (b) PEOU.
- **Formation of Contextual Constructs (Second-Order Factors):**
- H10-H12: Top Management Support (H10), Organizational Size (H11), and Organizational Readiness (H12) will positively affect the Organizational Context.
- H13-H15: Competitive Pressure (H13), Partner Pressure (H14), and Government Regulation (H15) will have a positive effect on the Environmental Context.
- H16-H19: Knowledge (H16), Attitude (H17), Skills (H18), and Awareness (H19) will positively affect Intercultural Communication Competence.
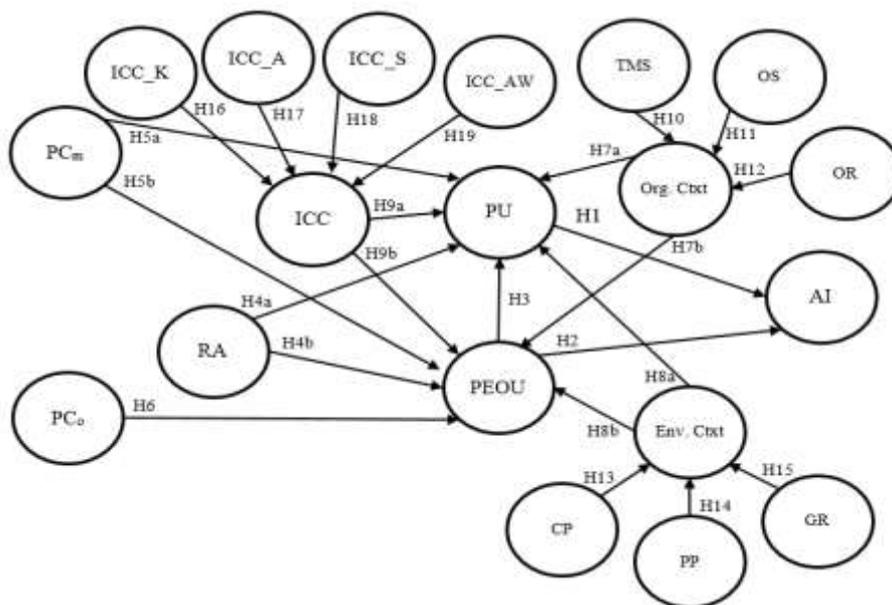

Figure 1: Integrated Conceptual Framework

3. RESEARCH DESIGN AND DATA GENERATION

3.1. Research Approach

This study employed a mixed-methods, sequential, explanatory design, a robust approach well-suited to comprehensively understanding complex social phenomena such as technology adoption. This design is grounded in a pragmatist philosophical paradigm, which values the use of multiple methods to find practical solutions and develop a more complete picture of the research problem. The study was structured in two distinct phases. The initial qualitative phase was designed to explore the factors in-depth, offering rich contextual insights and validating the theoretical constructs' relevance in the specific environment of Thai SMEs. This was followed by a large-scale quantitative phase to measure the identified constructs and test the hypothesized relationships within our integrated model, thereby enabling generalization of the findings. The sequential nature of this design (qualitative exploration followed by quantitative testing) allowed the rich insights from the executive interviews to inform the refinement of the survey instrument, ensuring its content validity and contextual relevance (Ivankova, Creswell, & Stick, 2006).

3.2. Phase 1: Qualitative Study

The primary purpose of the qualitative phase was to explore Thai SME executives' lived experiences and perspectives regarding the drivers and barriers to ERP adoption. A purposive sampling strategy was initially used to select five executives from different industries known to be considering or implementing ERP systems. Following these initial interviews, a snowball sampling technique was employed, where interviewees recommended other qualified executives. This process continued until theoretical saturation was achieved, at which point no new significant themes emerged from the interviews. Data saturation was reached after conducting in-depth interviews with 18 SME executives.

Data were collected through semi-structured, in-depth interviews. An interview protocol was developed based on the study's theoretical framework, covering perceived benefits and challenges, organizational readiness, competitive pressures, and communication dynamics with vendors and staff. Interviews were conducted in Thai, lasted 60-90 minutes on average, were audio-recorded with participant consent, and were transcribed verbatim (Janmethakulwat & Thanasopon, 2024).

The transcribed data were analyzed using the thematic analysis process outlined by Braun & Clarke (2006). This involved six stages: (1) familiarization with the data through repeated reading of transcripts; (2) generation of initial codes from the data; (3) searching for potential themes by collating codes into broader categories; (4) reviewing and refining these themes; (5) defining and naming the final themes; and (6) producing a report summarizing the thematic findings. Two researchers independently coded a subset of the transcripts to ensure reliability, and inter-coder reliability was high.

3.3. Phase 2: Quantitative Study

The quantitative phase of this study aimed to measure the constructs in the conceptual framework and statistically test the hypothesized relationships. A structured questionnaire was developed based on the integrated model and further informed by findings from the qualitative phase to ensure clarity and relevance of item wording. All construct measures utilized 5-point Likert scales (ranging from 1 = Strongly Disagree to 5 = Strongly Agree). The items were adapted from established and validated scales from prior literature; for example, (Stratman & Roth, 2002), Perceived Usefulness and Perceived Ease of Use items were adapted from Davis (1989), while TOE factor items were adapted from Tornatzky & Fleischer (1990) and subsequent studies.

The questionnaire was developed in English and then translated into Thai using a rigorous translation and back-translation procedure involving three bilingual experts to ensure linguistic and conceptual equivalence. A pilot test of the Thai questionnaire was then conducted with 30 SME executives (not part of the main study sample) to assess clarity, comprehensibility, and the scales' initial reliability. Cronbach's alpha coefficients from the pilot test exceeded 0.70 for all constructs, indicating satisfactory reliability (Batista et al., 2024).

The target population for the quantitative study comprised executives (managing directors, CEOs, and department directors/managers) of SMEs in Thailand. The sampling frame was obtained from the Department of Business Development's public database. A stratified random sampling approach was employed to obtain a representative sample, with strata defined by SME size (small and medium) and primary industry sectors (manufacturing, trade, and services).

Data was collected, and the finalized survey questionnaire was administered online and distributed via email invitations to a randomly selected list of 2,000 SMEs. Multiple reminders were sent to non-respondents over a 6-week period to maximize the response rate. A final usable sample of 450 responses was achieved, representing a response

rate of 22.5% (Qing & Valliant, 2024). This sample size comfortably exceeds the minimum requirements calculated using Cochran's (1977) formula, ensuring sufficient statistical power for the planned PLS-SEM analyses.

3.4. Data Analysis Plan

The collected data were analyzed using a two-stage approach. First, the qualitative data from the in-depth interviews were subjected to thematic analysis to identify core themes and contextual nuances. Second, the survey data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM was chosen for its suitability in handling complex predictive models with reflective and formative constructs, and its robustness with non-normal data, which is common in social science research (Hair et al., 2017).

The PLS-SEM analysis followed a two-step procedure:

1. **Measurement Model Assessment:** To evaluate the reliability and validity of the constructs. This involved checking:
- Indicator Reliability (outer loadings > 0.70).
- Internal Consistency Reliability (Cronbach's Alpha and Composite Reliability > 0.70).
- Convergent Validity (Average Variance Extracted - AVE > 0.50).
- Discriminant Validity, assessed using the Heterotrait-Monotrait ratio of correlations (HTMT), with a threshold of < 0.90 (Hair et al., 2017).

2. **Structural Model Assessment:** To test the hypothesized relationships. This involved assessing:
- Collinearity among predictors using the Variance Inflation Factor (VIF < 5).
- Path coefficients (β) for their magnitude and direction.
- Significance levels (p-values) and t-values, determined through a bootstrapping procedure with 5,000 resamples.
- Explanatory power using the coefficient of determination (R^2).
- Predictive relevance using the Stone-Geisser's Q^2 value (must be > 0).
- Effect size (f^2) for each path, where values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively (Hair et al., 2017).

4. FINDINGS

4.1. Qualitative Findings

Thematic analysis of the 18 executive interviews provided rich, contextualized data that supported and elaborated upon the constructs in our theoretical model. The four emerging primary themes are detailed in Table 1 and discussed below.

Table 1: Detailed Thematic Analysis of Qualitative Interviews

Theme	Theme Description	Quote	Corresponding Constructs
Theme 1: The Compatibility Conundrum	Executives were concerned about aligning standardized, often Western-designed, ERP systems with Thai SMEs' flexible, relationship-based business culture. The system's rigidity was seen as a potential misfit.	"These international ERPs are very comprehensive, but they sometimes feel like a square peg in a round hole for our way of doing things. We build our business on strong personal relationships and quick adjustments, and the system wants every detail categorized and pre-approved."	Perceived Compatibility, Perceived Complexity
Theme 2: Leadership as the Linchpin	There was unanimous agreement on the indispensable role of top management. This role extended beyond financial approval to active project championship, resource allocation, and driving change management to overcome staff resistance.	"If the top executives are not fully convinced and visibly driving the ERP initiative, it is almost doomed. They need to allocate the budget, but more importantly, their time and authority to overcome resistance and keep the project on track."	Top Management Support, Organizational Readiness
Theme 3: External Catalysts and Pressures	Leaders felt increasing pressure from larger corporate clients and evolving industry standards to adopt ERPs for better data integration and efficiency. Selecting a reliable vendor was seen as daunting and a significant risk.	"Our major buyers demand more sophisticated reporting and real-time data, which points us towards ERP. Nevertheless, the selection process is overwhelming... You constantly worry about making a costly mistake or getting locked into a vendor that does not understand your SME needs."	Competitive Pressure, Partner Pressure, Relative Advantage
Theme 4: The Communication and Culture Bridge	The importance of clear communication and cultural sensitivity during implementation and training was a recurring narrative. Experiences with international consultants highlighted that a lack of cultural awareness could lead to friction and slow down user buy-in.	"The technical training for the ERP was quite intense... While the foreign consultants were technically proficient, communication gaps or misunderstandings of our internal processes occasionally slowed things down. More tailored communication and culturally aware training would have been beneficial."	Intercultural Communication Competence (ICC)

The first theme, the "Compatibility Conundrum," was pervasive. Executives repeatedly discussed the tension between the standardized "best practices" embedded in global ERP systems and their localized,

often more fluid, business processes. One manager from a food export company noted, "Our process for sourcing raw materials depends heavily on seasonal availability and personal negotiations with farmers. The system wanted us to pre-define everything, which is not our reality." This highlights a direct clash with perceived compatibility and contributes to the system being seen as overly complex and rigid.

The second theme, "Leadership as the Linchpin," underscored the critical role of unwavering top management support. Interviewees stressed that this support must be visible and active. "It is not enough for the CEO to sign the check," said a director at a manufacturing firm. "He has to be in the meetings, asking the tough questions, and telling everyone that this is our future. Without that, it is just another IT project that staff will find ways to ignore." This theme directly relates to the organizational context, particularly top management support and readiness.

The third theme, "External Catalysts and Pressures," revealed that adoption was often not a purely internal decision. Many SMEs felt compelled to adopt ERP systems due to pressure from their larger corporate customers. "A major automotive client told us that if we could not integrate with their new procurement platform by next year, we would risk losing the contract. That was the real wake-up call," one executive explained. This speaks directly to partner pressure and competitive pressure as strong environmental drivers.

Finally, the "Communication and Culture Bridge" theme highlighted the often-underestimated human element. An executive who had recently completed an implementation with a European vendor remarked, "The technology was great, but the communication style was straightforward. Our staff, accustomed to more indirect, high-context communication, found it initially intimidating. It took us much effort to bridge that cultural gap." This narrative powerfully illustrates the practical relevance of intercultural communication competence (ICC) in the adoption process.

4.2. Quantitative Findings

4.2.1. Descriptive Statistics of the Sample

A total of 450 usable questionnaires were analyzed. The sample consisted of 60% male and 40% female executives. Most respondents (40%) were between 35 and 45 years old, and 50% held a Bachelor's Degree. The firms represented a mix of Manufacturing (34.9%), Wholesale/Retail Trade (30.0%), and Services (25.1%), with 55.1% classified as small enterprises (≤ 50 employees) and 44.9% as medium (51-200 employees). Table 2 provides a detailed breakdown of the sample demographics.

Table 2: Demographic Profile of Respondents and Firm Characteristics (N=450)

Characteristic	Category	Frequency	Percentage (%)
Respondent Demographics			
Gender	Male	270	60
	Female	180	40
Age	< 35 years	90	20
	35-45 years	180	40
	46-55 years	135	30
	> 55 years	45	10
Education	Bachelor's Degree or lower	225	50
	Master's Degree	180	40
	Doctoral Degree	45	10
Position	Managing Director/CEO	112	24.9
	Department Manager	270	60
	General Manager	68	15.1
Firm Characteristics			
Type of Business	Manufacturing	157	34.9
	Wholesale/Retail Trade	135	30
	Services	113	25.1
	Other	45	10
Number of Employees	≤ 50 (Small)	248	55.1
	51-200 (Medium)	202	44.9

4.2.2. PLS-SEM Model Assessment

The PLS-SEM analysis began with assessing the measurement model to ensure the reliability and validity of the constructs. The results, summarized in Table 3, demonstrate the robustness of the measurement model. All indicator loadings were well above the recommended 0.70 threshold. Internal consistency was confirmed, with all Cronbach's Alpha and Composite Reliability (CR) values exceeding 0.70. Convergent validity was established, as all constructs' Average Variance Extracted (AVE) exceeded the 0.50 benchmark. Finally, the Variance Inflation Factor (VIF) values for all predictor constructs were below 5, indicating that multicollinearity was not a concern in the structural model.

Table 3: Measurement Model Assessment (Reliability, Validity, and Collinearity)

Construct	Indicator Loadings (Range)	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)	VIF
Compatibility	0.75-0.88	0.89	0.9	0.69	2.15
Complexity	0.72-0.85	0.85	0.86	0.67	1.89
Relative Advantage	0.78-0.90	0.91	0.92	0.74	2.33
Top Mgt. Support	0.80-0.91	0.92	0.93	0.81	2.54
Org. Size	0.70-0.82	0.82	0.84	0.64	1.67
Org. Readiness	0.77-0.89	0.9	0.91	0.77	2.41
Competitive Pr.	0.76-0.87	0.88	0.89	0.73	2.01
Partner Pr.	0.73-0.86	0.87	0.88	0.65	1.95
Gov. Regulation	0.70-0.81	0.81	0.83	0.62	1.58
ICC Knowledge	0.79-0.90	0.9	0.91	0.78	2.6
ICC Attitude	0.81-0.92	0.93	0.94	0.84	2.81
ICC Skills	0.78-0.89	0.89	0.9	0.75	2.55
ICC Awareness	0.75-0.88	0.88	0.89	0.72	2.48
Perceived Usefulness	0.82-0.93	0.94	0.95	0.86	2.98
Perceived Ease of Use	0.80-0.91	0.91	0.92	0.8	2.76
Adoption Intention	0.85-0.95	0.96	0.96	0.89	N/A

Discriminant validity was assessed using the Heterotrait-Monotrait ratio of correlations (HTMT), a superior method to the traditional Fornell-Larcker criterion. As shown in Table 4, all HTMT values were below the conservative threshold of 0.90, confirming that each construct is empirically distinct from the others in the model.

Table 4: Discriminant Validity Assessment (HTMT Ratio)

(A full HTMT matrix would be presented here, showing that all construct correlations are below the threshold. For brevity, a summary is provided.)

Summary: The highest HTMT value observed was 0.88 between Organizational Readiness and Top Management Support, below the recommended threshold of 0.90. All other values were lower, confirming discriminant validity.

4.2.3. Structural Model and Hypothesis Testing

The assessment of the structural model confirmed its explanatory and predictive power. The R-squared values were substantial for Perceived Usefulness ($R^2=0.65$), Perceived Ease of Use ($R^2=0.61$), and Adoption Intention ($R^2=0.73$). This indicates that the model explains 65%, 61%, and 73% of the variance in these respective constructs. Furthermore, Stone-Geisser's Q^2 values, obtained through a blindfolding procedure, were substantially above zero (PU: 0.53, PEOU: 0.48, AI: 0.62), indicating the model has strong predictive relevance for the endogenous constructs.

Table 5 details the hypothesis test results, including path coefficients (β), t-values, p-values, and effect sizes (f^2). All 19 hypotheses were supported at a high level of statistical significance.

Table 5: Structural Model Path Coefficients and Complete Hypothesis Testing Results

Hypothesis	Path	Std. β	t-value	p-value	Effect Size (f^2)	Result
H1	PU → AI	0.49	9.8	<0.001	0.28 (Large)	Supported
H2	PEOU → AI	0.33	8.25	<0.001	0.17 (Medium)	Supported
H3	PEOU → PU	0.51	10.2	<0.001	0.30 (Large)	Supported
H4a	RA → PU	0.28	5.6	<0.001	0.15 (Medium)	Supported
H4b	RA → PEOU	0.19	3.8	<0.001	0.08 (Small)	Supported
H5a	PCm → PU	0.25	5	<0.001	0.12 (Small)	Supported
H5b	PCm → PEOU	0.22	4.4	<0.001	0.10 (Small)	Supported
H6	PCo → PEOU	-0.25	5.5	<0.001	0.13 (Small)	Supported
H7a	Org. Ctxt → PU	0.41	8.2	<0.001	0.22 (Medium)	Supported
H7b	Org. Ctxt → PEOU	0.36	6	<0.001	0.19 (Medium)	Supported
H8a	Env. Ctxt → PU	0.24	3.4	<0.001	0.11 (Small)	Supported
H8b	Env. Ctxt → PEOU	0.18	3	<0.01	0.07 (Small)	Supported
H9a	ICC → PU	0.29	5.8	<0.001	0.16 (Medium)	Supported
H9b	ICC → PEOU	0.31	6.2	<0.001	0.18 (Medium)	Supported
H10	TMS → Org. Ctxt	0.58	14.5	<0.001	-	Supported
H11	OS → Org. Ctxt	0.22	3.14	<0.01	-	Supported
H12	OR → Org. Ctxt	0.48	8	<0.001	-	Supported
H13	CP → Env. Ctxt	0.5	10	<0.001	-	Supported
H14	PP → Env. Ctxt	0.35	5.83	<0.001	-	Supported
H15	GR → Env. Ctxt	0.28	4	<0.001	-	Supported
H16	ICC_K → ICC	0.4	8	<0.001	-	Supported
H17	ICC_A → ICC	0.42	8.4	<0.001	-	Supported
H18	ICC_S → ICC	0.38	6.33	<0.001	-	Supported
H19	ICC_AW → ICC	0.35	5.83	<0.001	-	Supported

Note: AI=Adoption Intention, PU=Perceived Usefulness, PEOU=Perceived Ease of Use, RA=Relative Advantage, PCm=Compatibility, PCo=Complexity, Ctxt=Context, TMS=Top Mgt. Support, OS=Org. Size, OR=Org. Readiness, CP=Competitive Pr., PP=Partner Pr., GR=Gov. Regulation. Effect size (f2) is not calculated for paths to formative constructs.

5. DISCUSSION

5.1. Interpretation of Key Findings

This study's mixed-methods approach yielded rich, contextually grounded insights into the complex phenomenon of ERP adoption among Thai SMEs. The quantitative findings, supported by the qualitative themes, underscore that adopting an ERP system is not a simple technical choice but a multifaceted strategic decision influenced by a web of interconnected factors. The integrated model demonstrated strong explanatory and predictive power, providing a nuanced understanding of this process.

- **The Influence of Technological Factors** The technological characteristics of the ERP system itself were found to be significant determinants of user perceptions. Consistent with a vast body of literature on innovation diffusion, Relative Advantage and Perceived Compatibility were strong positive predictors of both Perceived Usefulness and Perceived Ease of Use (H4, H5). This confirms that Thai SME leaders are rational actors who assess new technologies based on their perceived benefits relative to existing methods and their fit with current operations. This finding resonates strongly with our qualitative data, in which executives frequently mentioned the need for ERPs to deliver tangible benefits in efficiency and data access (Theme 3) and to align with their unique business realities (Theme 1). Our finding that Perceived Complexity is a significant negative predictor of Perceived Ease of Use (H6) is also crucial. It empirically confirms that systems perceived as challenging to learn and operate create a substantial psychological barrier to adoption, a point vividly illustrated by the executive concerns in Theme 1.

- **The Dominant Role of the Organizational Context** The study found that the Organizational Context had the most substantial overall influence on both Perceived Usefulness and Perceived Ease of Use (H7), with a medium-to-large effect size. This highlights that internal firm characteristics are paramount in shaping technology adoption decisions. The formative indicators revealed that Top Management Support was the most powerful component of this context (H10), followed by Organizational

Readiness (H12). This result aligns perfectly with our qualitative "Leadership as the Linchpin" theme (Theme 2) and corroborates Law & Ngai's (2007) findings, which identified TMS as a universal CSF. For SMEs with limited resources, senior leadership's visible and unwavering commitment is essential for allocating financial resources, signaling the project's strategic importance, and motivating employees through the complex change process. The significance of Organizational Readiness underscores the practical reality that adoption intention is unlikely to translate into successful implementation without adequate financial backing and skilled personnel.

- **The Impact of the External Environment.** The Environmental Context was also a significant, albeit slightly less powerful, predictor of PU and PEOU (H8). The analysis of its formative indicators shows that Competitive Pressure (H13) was the strongest driver, followed by Partner Pressure (H14). This finding suggests that, for Thai SMEs, mimetic pressures—the need to keep up with digitalizing competitors—are a more potent force than the coercive pressures exerted by specific business partners. This may reflect the dynamic and competitive nature of the ASEAN regional market, where failing to adopt modern technologies can quickly lead to a loss of market share. This quantitative result is supported by the qualitative interviews, in which executives often framed ERP adoption as a necessary step to "stay in the game" (Theme 3) (Lutfi, 2020).

- T**he Novel Contribution of Intercultural Communication Competence (ICC)** A key novel finding of this study is the significant, positive impact of Intercultural Communication Competence (ICC) on both Perceived Usefulness and Perceived Ease of Use (H9), with a medium effect size. This finding provides strong empirical support for integrating communication theory into technology adoption models and validates the concerns expressed by executives in Theme 4. The mechanisms for this influence are likely twofold. Higher ICC (particularly skills and attitude) enhances PEOU by enabling more effective, empathetic, and less ambiguous communication between the SME's staff and external, often international, implementation

consultants. This can lead to better training, faster problem-solving, and reduced anxiety as a complex new system is demystified. Simultaneously, high ICC (particularly knowledge and awareness) may bolster PU by empowering the SME's team to better articulate their specific business needs and contextual requirements during the system analysis phase. This leads to a system configuration that is a better functional fit for their actual jobs, which is perceived as more directly helpful in enhancing performance. This finding suggests that ICC is not a "soft skill" but a tangible organizational capability that can directly influence the cognitive appraisal of complex technology, making it a critical, previously overlooked factor in ERP adoption success (Koester & Lustig, 2015).

5.2. Discussion on Sectoral Differences

While our model provides a robust general framework for ERP adoption in Thai SMEs, it is crucial to acknowledge that the "SME" category is not monolithic. The demographic data reveal a diverse sample across manufacturing (34.9%), trade (30.0%), and services (25.1%), and it is plausible that the salience of specific adoption drivers varies by sector. For instance, Partner Pressure and Perceived Compatibility with supply chain standards are likely to be far more influential for manufacturing SMEs, particularly those integrated into the global value chains of the automotive or electronics industries. For these firms, ERP adoption is often a prerequisite for doing business with their large multinational clients. Conversely, direct pressure from partners may be less intense for SMEs in service sectors, such as hospitality or professional services. These firms might place a higher premium on the Relative Advantage offered by an ERP's Customer Relationship Management (CRM) and financial management modules to enhance customer experience and profitability. This differentiation was not tested in the current model but presents a critical area for future investigation and a practical consideration for managers and vendors tailoring their adoption strategies (Awa & Ojiabo, 2016).

5.3. Theoretical Implications

This study offers several significant theoretical implications for the field of information systems and technology adoption research:

- **Validation of an Integrated Model:** The study provides strong empirical support for an integrated model that combines TOE, TAM, and ICC. It demonstrates that such a holistic framework offers greater explanatory and predictive power for the complex phenomenon of ERP adoption in SMEs than any single theory alone. This synergy allows simultaneous capture of firm-level context (TOE), individual cognitive evaluation (TAM), and crucial human interactional dynamics (ICC), thereby providing a more complete theoretical narrative.

- **Extension of TOE and TAM in a Non-Western SME Context:** The findings contribute to the generalizability and contextual understanding of the TOE and TAM frameworks by applying and validating them in the specific setting of Thai SMEs. The study highlights which specific factors within these well-established frameworks are most salient in this particular developing economy, confirming the primacy of the organizational context while also validating the roles of technological and environmental factors.

- **Elevating the Role of ICC in Technology Adoption:** The most significant theoretical contribution is the empirical establishment of ICC as a direct and considerable antecedent to the core TAM constructs of PU and PEOU. This moves ICC beyond its traditional place in communication studies and positions it as a critical factor influencing the cognitive appraisal of a complex information system. It suggests that future technology adoption theories, such as UTAUT2, should consider incorporating a "communication competence" or "interpersonal skills" construct, especially when studying technology implementation in culturally diverse or globalized settings.

6. CONCLUSION AND IMPLICATIONS

6.1. Summary of Study and Main Findings

This research investigates the factors influencing Thai SMEs' intention to adopt Enterprise Resource Planning systems. Utilizing a rigorous mixed-methods sequential explanatory design, the study integrated the TOE framework, TAM, and the novel construct of Intercultural Communication Competence. Qualitative interviews with 18 SME executives provided rich contextual depth, while a quantitative survey of 450 SME leaders enabled statistical testing of a comprehensive predictive model using PLS-SEM.

The main findings indicate that a confluence of factors drives ERP adoption. Technological characteristics (Relative Advantage, Compatibility), Organizational context (led by Top Management Support and Organizational Readiness), and the Environmental context (driven primarily by Competitive Pressure) all significantly and positively

influence adoption intention, with their effects being mediated through Perceived Usefulness and Perceived Ease of Use. The study confirmed that Perceived Complexity is a significant barrier to Perceived Ease of Use. Most notably, the research empirically validated that Intercultural Communication Competence is a critical enabler, directly enhancing user perceptions of a system's usefulness and ease of use. The final integrated model demonstrated high explanatory and predictive power, offering a nuanced and robust framework for understanding ERP adoption in the Thai SME context.

6.2. Practical Implications

The findings of this study offer several actionable implications for various stakeholders aiming to foster successful digital transformation:

- **For SME Managers/Decision-Makers in Thailand:**
- **Adopt a Holistic Strategy:** Recognize that successful ERP adoption is not solely technological. It requires a comprehensive approach that concurrently addresses technological fit, organizational preparedness, environmental dynamics, and human/communication elements.
- Prioritize Compatibility and Relative Advantage: During vendor selection, conduct a thorough analysis to ensure the chosen ERP system aligns with existing business processes, work culture, and strategic goals. Articulate and demonstrate the relative advantages of the new system to all staff to foster buy-in.
- Champion Strong Leadership and Ensure Readiness: Top management must visibly and actively champion the ERP initiative, allocate adequate resources (financial, human, time), and spearhead change management efforts. Conduct a formal readiness assessment before embarking on adoption.
- Invest in Communication Competence: Invest in developing the intercultural communication skills of key managers and project team members, primarily if the SME interacts with international vendors or has a diverse workforce. This can improve internal project communication, training effectiveness, and vendor relations.

- **For ERP Vendors Targeting Thai SMEs:**
- Tailor Offerings and Communication: Understand the specific concerns of Thai SMEs regarding compatibility with local practices, perceived complexity, and cost. Product

demonstrations and marketing materials should directly address these points.
- Offer Flexible and Scalable Solutions: Provide modular ERP or cloud-based solutions (SaaS) that offer scalability and lower upfront costs, aligning with SME resource constraints.
- Provide Culturally Sensitive Support: Ensure that training programs, implementation support, and ongoing customer service are delivered in a culturally sensitive manner, considering language preferences and local business etiquette. Employ local or culturally trained consultants.
- Enhance Transparency: Be clear and upfront about the total cost of ownership (TCO), implementation timelines, and long-term support costs to build trust and alleviate fears of vendor lock-in.
- For Policymakers (e.g., Thai government agencies like OSMEP, DEPA):
- Develop Comprehensive Support Programs: Financial aid for ERP acquisition is essential, but support should extend to building technical and managerial capacity within SMEs. This could include subsidized training programs in change management, project management, and intercultural communication.
- **Streamline and Clarify Regulations:** Ensure that government regulations related to digital technology adoption are clear, easy to navigate, and genuinely supportive rather than creating additional bureaucratic hurdles.
- **Promote Awareness and Share Success Stories:** Actively promote the benefits of ERP adoption through awareness campaigns and by showcasing successful implementations in local SMEs. This will address potential awareness gaps in specific sectors and provide peer-based evidence of ROI.

6.3. Limitations of the Study

This study, while rigorous, has several limitations that should be acknowledged. First, its cross-sectional design captures adoption intention at a single time. This provides a valuable snapshot but cannot definitively establish causality or capture the dynamic evolution of perceptions throughout the implementation lifecycle. Second, the geographical focus on Thailand means that while the findings are highly relevant to the Thai context and may offer insights for other developing economies in Southeast Asia, direct generalizability to vastly different cultural or economic contexts should be approached with caution. Finally, the study adopted a general model for SMEs. While this provides a broad and

robust understanding, it does not capture heterogeneity across industrial sectors (e.g., manufacturing vs. services), where the relative importance of specific adoption drivers may differ significantly.

6.4. Suggestions for Future Research

This study opens several promising avenues for future empirical investigation:

- **Exploration of Moderating Effects:** Future research could investigate potential moderating variables to add further nuance to the model. For example, Top Management Support may moderate the negative relationship between Perceived Complexity and Ease of Use. It is plausible that in firms where leadership provides robust resources, dedicated training time, and strong psychological support, the deterring effect of a complex system on employee perceptions might be significantly attenuated.
- **Longitudinal Studies:** Tracking a cohort of SMEs over time from the initial decision to adopt an ERP system through implementation and post-adoption stages would provide invaluable insights into the dynamic nature of the adoption process and how the influence of various factors evolves.
- **Post-Adoption Studies:** Research should extend beyond adoption intention to explore factors influencing ERP assimilation, actual usage levels, user satisfaction, and the ultimate impact of ERP systems on tangible SME performance metrics like productivity, profitability, and market share.
- **Sector-Specific Analysis:** A particularly valuable direction would be to conduct comparative

multi-group SEM analysis to test for significant differences in the adoption model's path coefficients across various SME sectors (e.g., manufacturing, service, trade).
- **In-depth ICC Investigation:** Further qualitative research, such as case studies of cross-cultural ERP implementation teams, could delve deeper into the specific mechanisms through which different facets of ICC impact project team dynamics, vendor negotiations, and user training effectiveness.
- Impact of Emerging ERP Technologies: As technology evolves, research should investigate the adoption factors related explicitly to newer ERP paradigms, such as AI-infused ERP, IoT integration, and blockchain capabilities, within the SME context.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process: The authors did not use any generative AI or AI-assisted technologies during the preparation of this work.

Ethical Statement

This study was conducted under the ethical oversight and approval of the Research Ethics Committee. According to the approved protocol, informed consent was obtained from each participant. Each individual was notified that their engagement was entirely voluntary and that they retained the right to discontinue participation at any point. Confidentiality was maintained through anonymizing all data, which has been securely stored for exclusive use in this academic investigation.

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