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Intergenerational technology adoption barriers in Indonesian family-owned MSME: A multi-level structural equation modeling analysis

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ABSTRACT

The digital transformation of Micro, Small, and Medium Enterprises (MSME) in Indonesia faces unique challenges in family owned businesses, where intergenerational dynamics significantly influence technology adoption decisions. This study examines how generational differences create barriers to technology adoption in Indonesian family owned MSME using a multilevel structural equation modeling approach. Using a multi-generational dyadic design with 350 family owned MSME representatives from two or more generations (N=700), we investigated the relationships between generational gaps, family harmony, and digital adoption intentions. Data were collected through structured interviews across traditional industries including textiles, food processing, and handicrafts. The results revealed that family harmony significantly mediates the relationship between generational gaps and technology adoption intentions (β=0.42, $p<0.001$), while communication quality moderates this relationship (β=0.28, $p<0.01$). Younger generations' technology advocacy proves more effective when combined with respect for older decision-making authority, suggesting that successful digital transformation requires culturally sensitive approaches that honor traditional family hierarchies while embracing technological innovation. This study contributes a theoretically grounded framework for understanding technology adoption in family businesses within collectivist cultures, offering practical implications for policymakers and business consultants in designing digital transformation programs for MSME.

Keywords: Intergenerational Dynamics, Technology Adoption, Family Business, MSME, Digital Transformation, Structural Equation Modeling, Generational Barriers

1. INTRODUCTION

Indonesia's economic landscape is fundamentally shaped by its 64.2 million Micro, Small, and Medium Enterprises (MSME), which contribute approximately 61.1% to the nation's Gross Domestic Product and employ 97% of the workforce (Akhmad et al., 2023). Among these enterprises, an estimated 85% operate as family owned businesses, where decision-making processes involve multiple generations, working within traditional hierarchical structures (Indriastuti & Ikmal, 2022). Despite the potential for digital transformation to enhance competitiveness and market reach, the Indonesian MSME faces significant challenges in adopting new technologies, particularly when generational differences create internal resistance to change. The Fourth Industrial Revolution created unprecedented opportunities for small enterprises to access global markets through digital platforms. However, Indonesian MSME adoption rates remain low, with several barriers hindering effective technology integration, including cost constraints, lack of digital literacy, and infrastructural deficiencies (Munandar et al., 2025). Existing research has extensively examined barriers to technology adoption from organizational and individual perspectives (Indriastuti & Ikmal, 2022). The unique dynamics of intergenerational decision making within family owned businesses have received limited attention in the Indonesian context.

Family owned businesses comprise a distinct organizational category shaped by the intersection of the family, ownership, and management systems (Iwu et al., 2024). These enterprises possess specific family languages that enable more efficient communication and information exchange with greater privacy, forming robust social communities defined by networks of relationships among organization members. However, the unique characteristics of family enterprises, particularly the significance of the family framework and the way relationships and values influence organizational culture, often lead family members to regard technology adoption as a lesser priority, driven by their aspiration to maintain the family heritage for succeeding generations. The intergenerational dimension adds complexity to technology adoption decisions in family businesses. As founding generations age, family firms enter critical periods of intergenerational inheritance and confront large-scale power transfers, which are frequently coupled with extended periods of teamwork as authority transitions from one generation to the next. Research indicates that family firms face unique challenges when adopting new technologies owing to their idiosyncratic characteristics, including concentrated ownership structures and decision-making processes, with various barriers affecting implementation processes (Canon et al., 2025).

This study investigated three critical research gaps in the literature. First, while studies on technology implementation have extensively applied the Technology Acceptance Model (TAM) and related frameworks (Ahmad et al., 2025; Rahimi et al., 2018), such models tend to concentrate on individual-level factors and fail to capture the complex multilevel dynamics present in family businesses. Second, existing studies on family business innovation typically examine single-generation perspectives (Beck et al., 2011; Hopwood, 2011), overlooking dyadic relationships and power dynamics between different generational cohorts. Third, research on Indonesian MSME digital transformation lacks theoretical frameworks that account for cultural values and traditional family structures that influence decision-making processes (Alfarizi & Kamila Hanum, 2023; Thohir, 2022). The research questions guiding this investigation are as follows: How do generational differences create barriers to technology adoption in Indonesian family owned MSME? What role does family harmony play in mediating the relationship between generational gaps and digital adoption intention? How do cultural values and traditional decision-making hierarchies moderate the technology adoption process in multigenerational family businesses?

This study offers valuable insights into the existing body of knowledge. Theoretically, it extends technology adoption research by incorporating intergenerational dynamics and cultural factors into a comprehensive multilevel model. Methodologically, it employs a novel dyadic approach that captures both the individual and relational factors that influence technology adoption decisions. The results offer practical guidance for policymakers designing digital transformation programs and business consultants working with family owned MSME in collectivist cultural contexts.

2. LITERATURE REVIEW

2.1. Technology Adoption in Small and Medium Enterprises

Technology adoption in small and medium enterprises has been extensively studied through various theoretical lenses, with the TAM as the primary theoretical model (Inayatulloh, 2020; Kalumendo, 2022). TAM includes various factors that account for individuals' behavioral intentions and their use of technology, such as perceived usefulness, perceived ease of use, and attitudes toward technology. Over time, it has been expanded by incorporating external elements, such as self-efficacy, social influence, and enabling conditions (Lee et al., 2025). The model has gained considerable prominence owing to its transferability to various contexts and samples, its potential to explain variance in intention to use technology, and its simplicity of specification within structural equation modeling frameworks (M. S. M. Ali et al., 2024).

However, technology adoption presents significant challenges for organizations, with many facing barriers when introducing or upgrading technology systems. Research on Indonesian MSME specifically reveals multiple barriers to its adoption. While there is a growing trend toward digital adoption among Indonesian MSMEs, several barriers hinder effective integration, including cost constraints, a lack of digital literacy, and infrastructural deficiencies. The digital transformation of Indonesian MSMEs offers substantial advantages, such as broader market access, improved operational efficiency, and enhanced profitability; however, it is hindered by challenges such as resource constraints, insufficient technical expertise, and concerns over data security (Munandar et al., 2025).

Recent studies have identified additional factors that influence technology adoption in developing countries. Common barriers include insufficient technological competencies, challenges related to managing complex data, ethical dilemmas, and difficulties in project integration and scalability (Zou et al., 2025). Small- and medium-sized enterprises face a range of limitations, including a lack of digital proficiency, underdeveloped infrastructure, and budgetary limitations, which restrict their capacity to utilize digital technologies to improve operational performance, engage customers, and expand market access (Sharabati et al., 2024).

2.2. Family Business Innovation and Technology Adoption

Family businesses exhibit distinct characteristics that influence their approaches to innovation and technology adoption (Hoicka, 2025; Laforet, 2013). Family businesses often rely heavily on internal expertise and typically pursue innovation through more insular methods, unless deliberate knowledge management strategies are in place. Studies indicate that such businesses allocate fewer resources to innovation, influenced by centralized family authority, the accumulation of family wealth, and the prioritization of non-economic objectives, yet demonstrate increased conversion rates of innovation input into output, with the effects being stronger when later-generation family members serve as CEOs (Zhang et al., 2025).

The intergenerational dimension significantly impacts technology adoption decisions in family businesses. Digital transformation significantly influences business processes and competitive advantage, as well as longevity and generational transition within family enterprises, offering an understanding of effective strategies and foreseeable obstacles (Billi & Bernardo, 2025). The adoption of digital tools introduces layered difficulties for family firms, as they are required to adapt to emerging technologies while preserving their distinctive family-driven identity, with succession planning adding further intricacy due to the need for successful generational transfer to sustain growth in the digital era (Ardyan et al., 2023).

Knowledge transfer within family businesses follows specific patterns influenced by generational relationships. Family characteristics, including the dedication of the succeeding generation, mutual trust among family members, and the quality of intergenerational ties shape organizational culture, influencing how knowledge is shared. Elements, such as familial trust, strong commitment to the enterprise, and close-knit relationships, play a crucial role in ensuring successful knowledge transfer (Yang et al., 2023).

Moreover, the implicit knowledge held by founders is a vital asset for developing a competitive edge because its intangible nature makes it challenging to replicate or exchange.

2.3. Generational Differences in Technology Adoption

Generational differences significantly influence technology adoption behaviors and preferences (Burkoski et al., 2019). Research shows that communicating with children and grandchildren when families are separated is an important motivator that drives elderly individuals to learn about information and communication technologies, although interest may diminish when family members return home (Aleti et al., 2023). The way older adults use and embrace technology varies from that of younger generations, largely because older adults are not surrounded by contemporary technological advancements. and faces new challenges due to rapid technological development (Genge et al., 2023).

Studies examining generational differences in the workplace context have revealed distinct patterns. Research indicates that there are variations in the motivations behind technology use among different generations; millennials predominantly engage with technology for entertainment and pleasure, whereas Generation X tends to use it mainly for practical functions and information seeking (Rattanapon et al., 2023). Additionally, family members often assist older adults in resolving issues related to technology use, and communication technology usage influences the daily structure and variety of everyday activities.

TAM has been successfully applied to understand generational differences in technology adoption. Research utilizing TAM with additional variables such as playfulness has verified the relationships between technological innovativeness and adoption behaviors, revealing differences in acceptance patterns between millennial consumers and their mature counterparts, thereby improving the understanding of generational differences in accepting innovative marketing technology.

2.4. Cultural Factors in Family Business Decision-Making

Cultural values play a crucial role in family business decision-making processes, particularly in collectivist societies, such as Indonesia (Georgas, 1989; Hofstede, 1983). Indigenous craft and traditional businesses often operate as female-headed family enterprises handed down from generation to generation, relying heavily on traditional brick-and-mortar retail channels and local tourism. and socio-economic challenges, such as low literacy rates and limited digital competencies, dependence on younger relatives and support from the community, as well as indigenous factors encompassing environmental conditions, cultural norms, and traditional knowledge.

The intersection of family dynamics and cultural values creates unique challenges for technology adoption in Indonesian business. Traditional family hierarchies emphasize respect for older authorities and collective decision-making processes (Laforet, 2013; Riany et al., 2017). These cultural factors must be considered when developing technology adoption frameworks for family owned MSME, as interventions that fail to account for traditional values may face resistance regardless of their technical merits.

3. RESEARCH METHOD

3.1. Study Design

This research employed a multi-generational dyadic study design to examine intergenerational technology adoption barriers in Indonesian family owned MSME. This study was conducted as a cross-sectional survey with structured interviews to capture both quantitative and qualitative insights from multiple generations within the same family businesses. The dyadic approach allowed for the examination of relational dynamics between generations, while controlling for family specific factors that might influence technology adoption decisions.

3.2. Sample and Respondent Characteristics

The target population consists of family owned MSME operating in traditional industries across Indonesia. Using purposive sampling, we recruited 350 family owned MSME with representatives from two or more generations, resulting in a total of 700 individual respondents. The sampling criteria required businesses to have been operating for at least 10 years, have clear family ownership (minimum 51% family control), and include active participation from at least two generational cohorts in business decision making (Haag et al., 2023). Participating MSME were selected from three traditional industries known for strong family business presence: textiles (n=120, 34.3%), food processing (n=140, 40.0%), and handicrafts (n=90, 25.7%). The geographic distribution included businesses from Java (60%), Sumatra (25%), Sulawesi (10%), and other Indonesian islands (5%). The generational distribution consisted of the founding generation (ages 55-75, n=350), second generation (ages 35-54, n=280), and third generation (ages 25-34, n=70).

Table 1 presents the demographic characteristics of the respondents, including their age distribution, education level, business tenure, and technological experience. The founding generation demonstrated lower formal education levels (65% high school or below) compared to younger generations (45% university educated for the second generation, 72% university educated for the third generation). Business tenure averaged 23.5 years for founding generation participants, 12.3 years for second generation, and 4.2 years for third generation participants, respectively.

Table 1. Demographic Profile of Respondents (N=700)

Characteristic	Founding Generation (n=350)	Second Generation (n=280)	Third Generation (n=70)
Age Range	55-75 years	35-54 years	25-34 years
Education	High School or Below: 75%	High School or Below: 45%	High School or Below: 15%
	University: 25%	University: 55%	University: 85%
Average Business Tenure	23.5 years	12.3 years	4.2 years
Daily Technology Use	2.1 hours	4.8 hours	7.2 hours
Digital Platform Familiarity	Low (35%)	Moderate (68%)	High (89%)

3.3. Data Collection

Data collection was conducted through face-to-face structured interviews supplemented with self-administered questionnaires during the period from March to August 2024. The interviews were conducted in Bahasa Indonesia by trained research assistants who were familiar with local business cultures. Each interview session lasted approximately 90 minutes and included both individual assessments and joint family discussions to capture the dyadic interactions. The interview protocol included validated scales adapted for the Indonesian context with items translated and back-translated to ensure linguistic equivalence. Pilot testing was conducted with 30 family businesses that were not included in the final sample to refine the instruments and ensure cultural appropriateness. All participants provided informed consent and the study received ethical approval from the university's institutional review board.

3.4. Measurement Model

This study employed established scales adapted to the Indonesian family business context. All constructs were measured using seven-point Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree). The measurement model includes six latent constructs with multiple indicators. **Generational Gap Score** is measured using a 12-item scale assessing differences in technology attitudes, risk perception, and business priorities between generational cohorts (Bigliardi & Dormio, 2009). Sample items included "Older and younger generations in our family have different views about technology benefits" (α=0.89). **Technology Self-Efficacy** was assessed using an 8-item scale adapted from computer self-efficacy measures (Aesaert et al., 2016; Doğru, 2017). Items contained "I have faith in my ability to pick up new digital features." (α=0.92).

Risk Perception regarding technology adoption was measured using a 6-item scale examining perceived financial, operational, and strategic risks (M. A. Ali et al., 2021; Choudhury et al., 2025). Sample items included "Adopting new technologies poses significant risks to our family business" (α=0.85). **Family Harmony** was measured using a 10-item scale assessing relationship quality, conflict resolution, and mutual respect within the family business (Hacker & Dowling, 2012; Lambrecht & Lievens, 2008). Items included "Family members respect each other's opinions in business decisions" (α=0.91). **Communication Quality** was assessed using an 8-item scale measuring the effectiveness, openness, and frequency of intergenerational communication (Cudris-Torres et al., 2021; Joanning et al., 1984). Sample items included "Different generations in our family communicate openly about business matters" (α=0.88). **Digital Adoption Intention** was evaluated using a 6-item scale modified from measures of technology adoption intention (Ayari & Yahia, 2023; Davis, 1989). The items included "Our family business intends to adopt digital technologies within the next two years" (α=0.90).

3.5. Validity and Reliability

Average Variance Extracted (AVE) values were used to evaluate convergent validity, and all constructs were found to be over the suggested cut-off of 0.50. According to the Fornell-Larcker criterion, discriminant validity was validated when each construct's square root of AVE was greater than its correlation with other components. The composite reliability (CR) values were all above the suggested minimum of 0.70, ranging from 0.85 0.94. Table 2 presents the validity and reliability metrics for each construct. Cronbach's alpha values, which showed strong internal consistency internally, was 0.85 to 0.92. The factor loadings for all measurement items exceeded 0.70, with most exceeding 0.80, demonstrating strong indicator reliability.

Table 2. Validity and Reliability Measures

Construct	AVE	CR	Cronbach's α	Mean	SD
Generational Gap Score	0.61	0.91	0.89	4.23	1.15
Technology Self-Efficacy	0.68	0.94	0.92	3.87	1.28
Risk Perception	0.59	0.89	0.85	4.56	1.09
Family Harmony	0.64	0.93	0.91	5.12	0.98
Communication Quality	0.62	0.91	0.88	4.78	1.05
Digital Adoption Intention	0.66	0.92	0.90	4.05	1.22

3.6. Model Fit and Statistical Analysis

With maximum likelihood estimation, AMOS 28.0 was used to model the structural equations. Missing data (less than 3% across all variables) were handled using a full information maximum likelihood (FIML) estimation. The measurement model was tested prior to the structural model evaluation to ensure adequate fit. Several goodness-of-fit indices were used to evaluate model fit in accordance with predetermined standards (Asgari et al., 2024; Vamvourellis et al., 2021). The measuring model showed a satisfactory fit: $\chi^2/df = 2.47$ (below 3.0), Comparative Fit Index (CFI) = 0.94 (above 0.90), Tucker-Lewis Index (TLI) = 0.93 (above 0.90), Root Mean Square Error of Approximation (RMSEA) = 0.046 (below 0.08), and Standardized Root Mean Square Residual (SRMR) = 0.052 (below 0.08). Multicollinearity was assessed using variance inflation factors (VIF), with all values below 3.0, indicating no significant multicollinearity issues. In order to evaluate the mediation hypotheses and produce 95% confidence intervals for indirect effects, bootstrapping techniques using 5,000 resamples were used. Multigroup analysis is a component of the analytical approach used to examine variations across industries and generations. Measurement invariance was tested across generational groups to ensure that the constructs were interpreted similarly across generations. Configural, metric, and scalar invariances were sequentially tested, with results supporting measurement invariance across groups.

3.7. Limitations and Ethical Considerations

Several methodological constraints must be noted. While the theoretical model and comprehensive controls for alternative explanations enhance the validity of the findings, the cross-sectional approach restricts the ability to draw conclusions on causality. Although these industries represent the majority of Indonesian family owned MSMEs, the focus on traditional industries may limit the generalizability to technology-intensive sectors. Self-report bias was addressed through multiple informants per family, triangulation with objective business data where available, and the inclusion of reverse-coded items. Harman's single-factor test and the marker variable methodology were used to evaluate common method bias, and the results showed that there were few bias issues. Ethical considerations included the protection of business confidentiality, voluntary participation, and cultural sensitivity in data collection procedures. Every participant provided written agreement after being briefed on the objectives of the study. University data protection procedures were followed in the anonymisation and safe storage of business data

4. RESULTS

4.1. Descriptive Statistics and Correlation Analysis

The reliability coefficients, correlations, and descriptive statistics for each study variable are presented in Table 3. The correlation matrix revealed significant relationships between most variables in the expected directions. Generational Gap Score showed moderate positive correlations with Risk Perception ($r=0.48$, $p<0.001$) and negative correlations with Digital Adoption Intention ($r=-0.35$, $p<0.001$). Family Harmony demonstrated strong positive correlations with Communication Quality ($r=0.62$, $p<0.001$) and Digital Adoption Intention ($r=0.51$, $p<0.001$). Technology Self-Efficacy had the strongest positive correlation with Digital Adoption Intention ($r=0.58$, $p<0.001$).

Table 3. Descriptive Statistics and Correlations

Variable	1	2	3	4	5	6	Mean	SD
1. Generational Gap Score	(0.89)						4.23	1.15
2. Technology Self-Efficacy	-0.28**	(0.92)					3.87	1.28
3. Risk Perception	0.48**	-0.31**	(0.85)				4.56	1.09
4. Family Harmony	-0.42**	0.35**	-0.38**	(0.91)			5.12	0.98
5. Communication Quality	-0.39**	0.41**	-0.33**	0.62**	(0.88)		4.78	1.05
6. Digital Adoption Intention	-0.35**	0.58**	-0.29**	0.51**	0.47**	(0.90)	4.05	1.22

Note: N=700. Diagonal values in parentheses are Cronbach's alpha coefficients. **p<0.01

Analysis of variance across generational groups revealed significant differences in all variables, except Family Harmony. The founding generation reported higher Risk Perception ($M=5.23$, $SD=0.87$) than the second ($M=4.34$, $SD=1.02$) and third generations ($M=3.78$, $SD=1.15$), $F(2,697)=78.45$, $p<0.001$. Technology Self-Efficacy showed the opposite pattern, with the third generation reporting the highest levels ($M=5.12$, $SD=0.93$), followed by the second generation ($M=4.15$, $SD=1.08$) and founding generation ($M=2.94$, $SD=1.22$), $F(2,697)=145.32$, $p<0.001$.

4.2. Structural Model Results

The data were in good agreement with the proposed structural model ($\chi^2/df = 2.31$, CFI = 0.95, TLI = 0.94, RMSEA = 0.043, and SRMR = 0.048). The final structural model, with standardized path coefficients and significance levels, is presented in Figure 1.

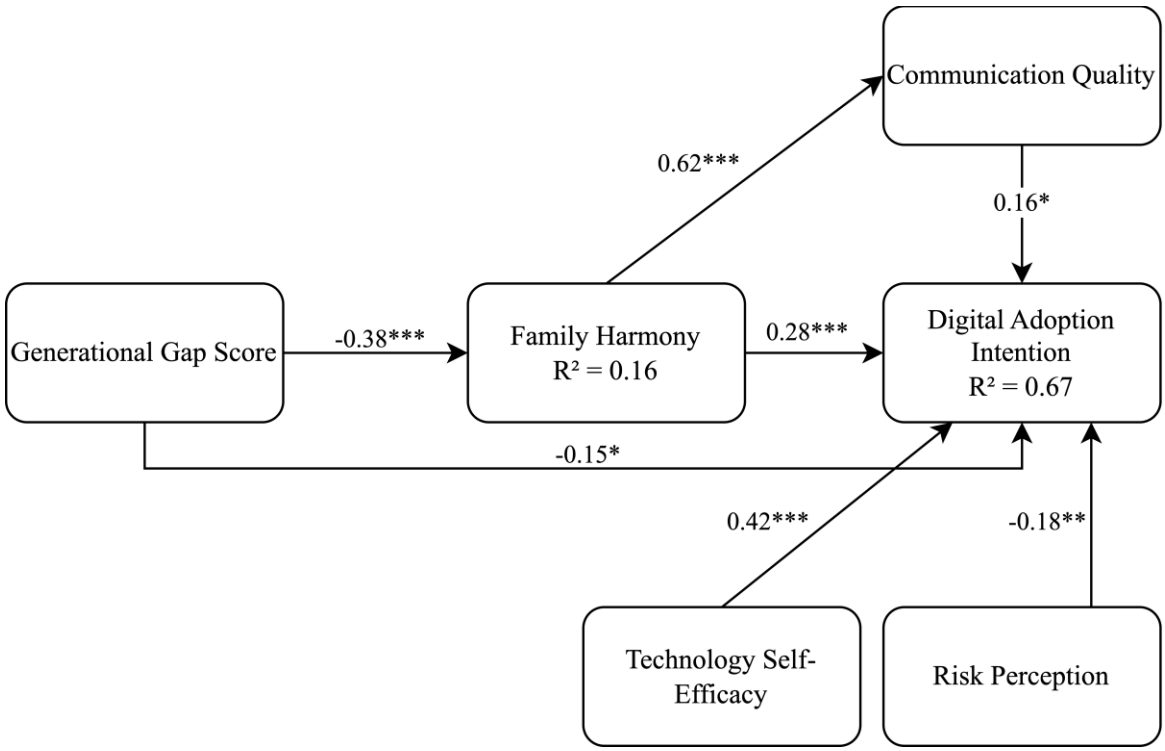

Figure 1. Structural Equation Model with Standardized Path Coefficients

Note: ***p<0.001, **p<0.01, *p<0.05. *R^2 values indicate the explained variance.*

The structural model explains 67% of the variation in Digital Adoption Intention and 16% of the variation in Family Harmony. Self-efficacy emerged as the most reliable indicator of the intention to adopt digital technology (β=0.42, p<0.001), followed by Family Harmony (β=0.28, p<0.001). The gap score showed significant negative direct effects on both Family Harmony (β=-0.38, p<0.001) and Digital Adoption Intention (β=-0.15, p<0.05).

4.3. Mediation Analysis

Bootstrap analysis revealed significant indirect effects, thus supporting the mediation hypothesis. The indirect effect of the Generational Gap Score on Digital Adoption Intention through Family Harmony was significant (β=-0.11, 95% CI [-0.16, -0.06], p<0.001). Partial mediation was shown by the fact that this mediation effect explained 41.5% of the overall impact of the gap score on Digital Adoption Intention (indirect effect of -0.106 divided by total effect of -0.256). Table 4 presents the decomposition of the effects for all paths in the model. The total effect of the gap score on digital adoption intention (β=-0.26) comprised both direct (β=-0.15) and indirect (β=-0.11) components. Family Harmony served as the primary mediating mechanism, suggesting that generational differences primarily influence technology adoption intentions through their impact on the quality of family relationships.

Table 4. Decomposition of Effects

Path	Direct Effect	Indirect Effect	Total Effect
GGS → DAI	-0.15*	-0.11***	-0.26***
TSE → DAI	0.42***	–	0.42***
RP → DAI	-0.18**	–	-0.18**

Path	Direct Effect	Indirect Effect	Total Effect
FH → DAI	0.28***	–	0.28***
CQ → DAI	0.16*	–	0.16*
GGS → FH	-0.38***	–	-0.38***

Note: GGS=Generational Gap Score, TSE=Technology Self-Efficacy, RP=Risk Perception, FH=Family Harmony, CQ=Communication Quality, DAI=Digital Adoption Intention. ***p<0.001, **p<0.01, *p<0.05

4.4. Multi-Group Analysis

A multi-group analysis across generational cohorts revealed interesting differences in path strengths and relationships. The model demonstrated measurement invariance across groups (ΔCFI < 0.01, ΔRMSEA < 0.015), allowing for a meaningful comparison of the structural paths (see Table 5).

Table 5. Multi-Group Analysis Results by Generation

Path	Founding Gen (n=350)	Second Gen (n=280)	Third Gen (n=70)	χ^2 difference
TSE → DAI	0.25**	0.52***	0.61***	18.45***
RP → DAI	-0.34***	-0.15*	-0.09 ns	12.67**
FH → DAI	0.38***	0.22**	0.18*	8.92**
GGS → DAI	-0.42***	-0.31***	-0.24**	7.34*
Indirect Effect (GGS→FH→DAI)	-0.160***	-0.068**	-0.043*	-

Note: ns = not significant. ***p<0.001, **p<0.01, *p<0.05

For the founding generation, Risk Perception had the strongest negative impact on Digital Adoption Intention (β=-0.34, p<0.001), while Technology Self-Efficacy had a moderate positive impact (β=0.25, p<0.01). In contrast, for the second and third generations, Technology Self-Efficacy emerged as the dominant predictor (β=0.52 and β=0.61, respectively, both p<0.001), while Risk Perception showed weaker effects. The mediation effect of Family Harmony was strongest for the founding generation, with the indirect effect of Generational Gap Score through Family Harmony being -0.160 (p<0.001) compared to the younger generations.

4.5. Industry and Cultural Moderation Effects

The analysis across industry sectors revealed significant differences in the strength of the relationships. Cultural value moderation was examined using traditional orientation scores (Table 6).

Table 6: Industry and Cultural Moderation Analysis

Moderator Variable	Path	Low	Moderate	High	χ^2 difference
Industry Type					
Textiles (n=120)	FH → DAI	0.22**	–	–	
Food Processing (n=140)	FH → DAI	0.28***	–	–	9.45**
Handicrafts (n=90)	FH → DAI	0.41***	–	–	
Traditional Orientation					
	FH → DAI	0.18*	0.21**	0.35***	11.23**
	GGS → FH	-0.28**	-0.36***	-0.45***	8.67*

Note: ***p<0.001, **p<0.01, *p<0.05*

Family Harmony showed stronger effects on Digital Adoption Intention in traditional handicrafts (β=0.41, $p<0.001$) compared to textiles (β=0.22, $p<0.01$) and food processing (β=0.28, $p<0.001$). Families with a higher traditional orientation showed stronger relationships between Family Harmony and Digital Adoption Intention (β=0.35, $p<0.001$) than those with a moderate (β=0.21, $p<0.01$) or low traditional orientation (β=0.18, $p<0.05$).

5. DISCUSSION

5.1. Key Findings and Comparison with Previous Research

This study reveals that family harmony serves as a critical mediating mechanism in the relationship between generational gaps and technology adoption intentions in Indonesian family owned MSME, accounting for 41.5% of the total effect. This finding extends the previous research on technology adoption in family businesses by demonstrating the central role of relational factors in adoption decisions. Unlike traditional TAM applications that focus primarily on individual-level perceptions (Hu et al., 1999; Pavlou, 2003), our results show that technology adoption in family businesses requires consideration of multilevel relational factors. The strong mediating role of family harmony aligns with recent research by Yang et al. (2023), who found that family characteristics, including mutual trust and the quality of intergenerational ties, significantly influence organizational culture and knowledge sharing. However, our study extends this work by empirically demonstrating how these relational factors mediate technology adoption decisions. This finding suggests that interventions targeting relationship quality may be more effective than traditional technology training approaches alone.

Our results regarding generational differences in technology self-efficacy and risk perception corroborate the findings of Rattanapon et al. (2023), who showed that millennials engage with technology primarily for hedonic purposes, whereas Generation X focuses on utilitarian functions. However, our study reveals an important nuance in that successful adoption still requires family consensus and harmony across generations, challenging purely individual-focused adoption models. The differential effects across generational cohorts, with Technology Self-Efficacy being more influential for younger generations (β=0.61, third generation) than founding generations (β=0.25), aligned with Burkoski et al. 's(2019) findings on generational technology adoption patterns.

The industry-specific differences we observed, particularly the stronger effect of Family Harmony on Digital Adoption Intention in traditional handicrafts (β=0.41) compared with other sectors, support Alfarizi and Kamila Hanum's (2023) argument that traditional businesses face unique challenges in digital transformation. This pattern suggests that technology adoption in more traditional industries requires greater attention to family relationship dynamics, extending beyond the technical and financial considerations typically emphasized in the literature.

5.2. Theoretical Implications

This study significantly contributes to both the technology adoption and family business literature by integrating intergenerational dynamics into technology adoption models. Our findings extend the TAM by demonstrating that in family business contexts, individual-level factors must be complemented by relational and cultural considerations. The identification of Family Harmony as a key mediator provides a theoretical bridge between technology adoption research and family business studies, suggesting that successful models must account for the collective nature of decision making in family enterprises. The differential impact of risk perception across generations, with founding generations showing stronger negative effects (β=-0.34) than younger generations, supports and extends Hoicka's (2025) work on intergenerational differences in family businesses. This finding suggests that risk perception operates differently across generational cohorts, with implications on how technology adoption models should incorporate age-related factors.

Our results on cultural moderation effects contribute to the growing literature on context-specific technology adoption. The stronger relationship between Family Harmony and Digital Adoption Intention in families with high traditional orientation (β=0.35) compared to low traditional orientation (β=0.18) supports Hofstede's (1983) and Georgas's (1989) arguments about the importance of cultural values in organizational behavior. This finding suggests that universal technology adoption models may have limited applicability to culturally diverse contexts.

5.3. Practical Implications

For practitioners working with family owned MSME in Indonesia and other comparable cultural contexts, the findings provide a number of practical insights. First, digital transformation programs should prioritize family relationship-building and consensus-building processes rather than focusing solely on technical training. Comprehensive policies and tailored training programs to facilitate digital adoption in MSMEs should explicitly incorporate family dynamics and intergenerational communication strategies.

Second, the strong role of Technology Self-Efficacy across all generational groups suggests that skill development remains important but must be approached in culturally appropriate ways. Training programs should involve multiple generations simultaneously, allowing for peer learning and knowledge transfer within families, while respecting traditional hierarchies. Studies demonstrating that family members frequently assist senior citizens with technology-related issues provide credence to the effectiveness of family centered training methods (Aleti et al., 2023).

Third, the moderating effects of cultural values indicate that standardized digital transformation programs may be less effective than culturally tailored interventions. Programs working in traditional industries or families with strong traditional orientations should place greater emphasis on demonstrating how technology adoption aligns with family values and long-term business sustainability. Conservative views on technology are frequently motivated by the need to protect family legacy for future generations, which suggests that interventions should bolster technology adoption rather than undermine traditional values (Zhang et al., 2025).

5.4. Policy Implications

The findings suggest several important considerations for policymakers designing digital transformation initiatives for Indonesian MSME. Current government programs such as "MSME Go Online" (Legowo et al., 2022; Tikno & Amelia, 2019) should incorporate family business dynamics into their design and implementation strategies. Rather than targeting individual business owners, programs should engage entire family business systems and provide support for intergenerational communication and consensus-building. The significant industry differences observed in this study suggest that sector-specific approaches may be more effective than generic digitalization programs. MSMEs can benefit from digital transformation by gaining access to new digital tools and procedures for global and sustainable business development. However, obstacles to digital adoption exist, particularly in the areas of infrastructure and public economic trends, which require further research. Traditional industries, such as handicrafts, may require more intensive relationship-building support than sectors with greater technology exposure.

Additionally, the role of risk perception, particularly among founding generations, indicates that programs should include comprehensive risk-mitigation strategies and insurance products to address concerns about technology adoption. Financial support mechanisms should consider the multi-generational nature of decision making and provide flexible arrangements that accommodate family consultation processes.

5.5. Limitations and Future Research Directions

Several limitations of this study should be acknowledged when interpreting these findings. The cross-sectional design limits our ability to establish causal relationships, although the theoretical model and extensive controls strengthened the validity of the findings. Future research should employ longitudinal

designs to track the technology adoption processes over time and examine how family dynamics evolve during digital transformation. The focus on traditional industries may limit the generalizability to more technology-intensive sectors or larger family businesses. Studies on MSME readiness for Industry 4.0 have been mostly conducted in manufacturing and are limited, creating research gaps that require investigation to provide insights on appropriate strategies and policies. Future research should examine whether similar patterns emerge in different industry contexts and organizational sizes.

The study's geographic focus on Indonesia limits its generalizability to other cultural contexts, although the theoretical framework may be applicable to other collectivist cultures with strong family business traditions. The identification of universal versus culture-specific elements that influence the adoption of technology in family businesses will be aided by comparative studies conducted in various cultural contexts. Future studies should also look at how outside parties, such as government organizations, consultants, and technology suppliers, help family businesses adapt new technologies. Research on family firms indicates that they seek to build social capital with stakeholders through cooperation and long-lasting relationships, suggesting that external relationships may complement internal family dynamics to support technology adoption (Zhang et al., 2025). Additionally, research should investigate the long-term outcomes of technology adoption in family businesses, including the impacts on business performance, family relationships, and intergenerational succession processes. Family businesses can plan for the future and guarantee long-term viability and success by understanding how digital technologies impact succession and continuity.

6. CONCLUSION

This research reveals the complex dynamics of technology adoption in Indonesian family owned MSME, demonstrating that family harmony serves as a key mediating mechanism through which generational differences influence digital adoption intentions. The finding that this mediation accounted for 41.5% of the total effect highlights the critical importance of relational factors in technology adoption decisions within family businesses. This suggests that successful digital transformation requires more than technical training and financial resources, and demands attention to family relationship quality and consensus-building processes. The differential effects across generational cohorts highlight the importance of multi-generational approaches to technology adoption. While the younger generations demonstrate higher technology self-efficacy, successful adoption still requires family consensus and respect for traditional decision-making hierarchies. This finding challenges individual-focused adoption models and emphasizes the collective nature of decision making in family businesses operating within collectivist cultural contexts.

These practical implications extend beyond individual businesses to policy design and implementation strategies. Digital transformation programs should incorporate family dynamics into their frameworks, provide culturally sensitive training approaches, and recognize industry-specific differences in family business traditions. The strong moderating effects of cultural values suggest that one-size-fits-all approaches may be less effective than tailored interventions that honor traditional values while promoting technological innovation. This study uses empirical data to support the significance of multilevel elements in technology adoption decisions, advancing both family business research and technology adoption theory. These findings support the development of more comprehensive theoretical models that account for relational dynamics and cultural factors, moving beyond purely rational choice models to embrace the complexity of family business decision-making processes.

For Indonesian policymakers and business development practitioners, the results offer actionable guidance for designing effective digital transformation programs. Recognizing that technology adoption in family businesses is fundamentally a social and relational process, interventions can be designed to support both technological capability building and family relationship strengthening, ultimately leading to more sustainable and successful digital transformation. This research demonstrates that intergenerational technology adoption barriers in Indonesian family owned MSME can be addressed through culturally

sensitive approaches that honor traditional family values while embracing technological innovation. Success requires understanding that technology adoption decisions in family businesses are embedded within complex webs of relationships, cultural values, and intergenerational dynamics that must be carefully navigated to achieve sustainable digital transformation

Ethical approval

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Informed consent statement

All participants were informed of the purpose of the study, and informed consent was obtained prior to data collection. Participation was voluntary, and all responses were kept confidential and used solely for academic research purposes.

Authors' contributions

Conceptualization, EP, and SA; methodology, EP., and SA; validation, EP and SA; formal analysis, EP and SA; resources, EP.; writing original draft preparation, EP., and SA; writing review and editing, EP., and SA.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

The data presented in this study are available on request from the corresponding author due to privacy reasons.

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