

**" Digital Capability as a Strategic Mediator between Blockchain Transparency and Cross-Border Digital Payments in Strengthening MSME Export Competitiveness and International Market Access "**

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**Abstract**

Digital transformation has become a strategic element for MSMEs in the ASEAN region to increase their involvement in international trade. This study examines the role of digital capabilities as a mediator in the relationship between blockchain transparency and cross-border digital payments on international market access and MSME export competitiveness. Using a quantitative approach with Partial Least Squares–Structural Equation Modeling (PLS-SEM) techniques, this study analyzes data obtained from MSMEs in various ASEAN countries that have adopted digital technology in their export activities.

The results show that blockchain transparency has a positive and significant effect on digital capability, international market access, and export competitiveness of MSMEs. Conversely, the adoption of cross-border digital payments did not significantly impact digital capability or MSME export performance. Digital capability was shown to have a positive effect on international market access and export competitiveness, while significantly mediating the relationship between blockchain transparency and both variables. However, digital capability did not mediate the effect of cross-border digital payments.

These findings confirm that digital capability is a key factor for MSMEs in leveraging blockchain technology to improve export performance, while the effectiveness of cross-border digital payments remains hampered by regulations, costs, and infrastructure readiness. This research has important implications for ASEAN governments, industry players, and MSMEs to strengthen digital ecosystems, harmonize cross-border policies, and accelerate the adoption of technologies relevant to international trade.

Keywords: Blockchain, , MSMEs, ASEAN.

**1. Introduction**

Micro, Small, and Medium Enterprises (MSMEs) are a key pillar of the ASEAN economy. More than 97% of companies in ASEAN countries are MSMEs, yet their contribution to exports remains relatively low compared to developed countries. The main challenges for MSMEs in penetrating international markets include limited access to global market information, limited digital capabilities, and persistently high barriers to cross-border transactions. Amidst the increasingly digitalized dynamics of global trade, the use of blockchain technology and international digital payment systems presents a strategic opportunity to reduce these barriers through transaction efficiency, increased transparency, and data security.

Blockchain, as a distributed record-keeping technology, offers transaction transparency and traceability, which can increase international buyers' trust in MSMEs. In the context of cross-border trade, blockchain transparency can mitigate the risk of asymmetric information, reduce verification costs, and strengthen MSMEs' reputations as accountable suppliers. Furthermore, cross-border digital payment systems such as cross-border QR codes, regional e-wallets, and international fintech platforms have become crucial instruments in accelerating export payment processes, reducing transaction costs, and increasing the convenience of international transactions. However, technology adoption does not automatically lead to increased export competitiveness and international market access. The strategic impact of these two technologies depends heavily

on MSMEs' digital capabilities. Digital capabilities reflect MSMEs' ability to understand, manage, and utilize digital technology for export business activities. Without adequate digital capabilities, the potential of blockchain and cross-border digital payments cannot be optimally utilized. Therefore, digital capabilities act as a strategic intermediary, enabling MSMEs to translate technology use into improved export performance.

In the ASEAN context, the level of digital technology penetration varies across countries. Singapore, Malaysia, and Thailand have already developed digital infrastructure and cross-border payment regulations, while Indonesia, Vietnam, Cambodia, and Laos are at the stage of strengthening digital adoption in the MSME sector. This difference in digital readiness reinforces the urgency of research into the role of digital capabilities as a mediating variable that can explain how blockchain technology and cross-border digital payments can improve the export competitiveness of MSMEs at the regional level.

Table 1 digital capabilities of MSMEs as mediators

Country	Status of MSME digital capabilities (briefly)	Blockchain Initiatives / examples	Cross-Border Payments Initiative (example)	Key policies/programs	Implications for the export competitiveness of MSMEs
<b>Singapore</b>	High — MSMEs are relatively mature in digital adoption & fintech support services.	Project Ubin (a DLT experiment for payment systems and asset tokenization). ( <a href="https://www.mas.gov.sg">mas.gov.sg</a> )	Cross-border payment network via banks & Alipay+/global fintech partners (industry initiative). ( <a href="https://www.reuters.com">Reuters</a> )	MAS and a robust digital/fintech roadmap; digital MSME support programs. ( <a href="https://www.mas.gov.sg">mas.gov.sg</a> )	MSMEs that are able to utilize tokenization/cross-border payments get faster payment processes & international buyer trust.
<b>Malaysia</b>	Medium-high digital capabilities; many MSMEs on e-commerce platforms.	DLT pilots/testing in several sectors (private & regulatory initiatives).	DuitNow–PayNow / cross-border QR link (commercialization of ID/QR links between MY & SG/ID). ( <a href="https://www.bnm.gov.my">bnm.gov.my</a> )	Bank Negara Malaysia (BNM) supports cross-border payment connectivity (QR linkages). ( <a href="https://www.bnm.gov.my">bnm.gov.my</a> )	Make it easier for MSMEs to receive international payments (lower costs) and speed up settlement → support micro/SME exports.
<b>Indonesia</b>	Striving to rapidly improve the digital capabilities of MSMEs; numerous training programs and payment infrastructure.	Several blockchain pilots for supply-chain & e-ledger (research/implementation).	Cross-border QRIS (linkage to several countries; implementation and commercialization with regional central banks). ( <a href="https://www.bankindonesia.co.id">Bank Indonesia</a> )	BI Blueprint for the Indonesian Payment System 2025; MSME digitalization program (relevant ministries). ( <a href="https://www.bankindonesia.co.id">Bank Indonesia</a> )	Cross-border QR schemes and digital capabilities can expand regional buyer access and reduce the friction of MSME export payment costs.
<b>Thailand</b>	MSMEs' digital capabilities are quite advanced in	DLT experiments in specific sectors (research & pilots).	PromptPay-PayNow & QR links with other countries (e.g. Singapore) facilitate	The Bank of Thailand (BoT) is actively promoting payment	MSMEs can leverage the QR network for payments to tourists & regional buyers — increasing the volume of

	large cities; improvements are underway in the regions.		cross-border QR payments. ( <a href="http://bot.or.th">bot.or.th</a> )	linkages and digital inclusion. ( <a href="http://bot.or.th">bot.or.th</a> )	small export transactions.
<b>Vietname</b> <b>e</b>	Digital capabilities are rapidly increasing (national digital transformation program).	National blockchain strategy (roadmap to 2025/2030) for cross-sector applications. ( <a href="http://beta-en.mic.gov.vn">beta-en.mic.gov.vn</a> )	Digital payments initiative and digital transformation program for MSMEs (national). ( <a href="http://vietnam-briefing.com">vietnam-briefing.com</a> )	The National Digital Transformation Programme (until 2025/2030) and the national blockchain strategy. ( <a href="http://vietnam-briefing.com">vietnam-briefing.com</a> )	National policies accelerate technology adoption; MSMEs that enhance their digital capabilities are more export-ready.
<b>Philippines</b>	Digital payment adoption is growing rapidly; MSMEs are increasingly onboarding e-wallets and marketplaces.	Several sectoral blockchain pilots (research & private).	The growth of e-payments and remittance services; e-wallet platforms (GCash, PayMaya) are expanding cross-border flows. ( <a href="http://bsp.gov.ph">bsp.gov.ph</a> )	The BSP is pushing for e-payments inclusion; the MSME digitalization program is part of its development plan. ( <a href="http://bsp.gov.ph">bsp.gov.ph</a> )	Payment connectivity & e-wallet adoption facilitates working capital/export billing for MSMEs, but capabilities are still heterogeneous.
<b>Cambodia</b>	Digital capabilities are evolving rapidly through central initiatives (especially payments).	<b>Bakong</b> — a national DLT/rail-based payment system that is gaining regional attention. ( <a href="http://ledgerinsights.com">ledgerinsights.com</a> )	Bakong + KHQR and cross-border linkages (UnionPay, UPI, collaboration with other countries). ( <a href="http://nbc.gov.kh">nbc.gov.kh</a> )	The National Bank of Cambodia (NBC) is actively developing Bakong and promoting digital inclusion. ( <a href="http://ledgerinsights.com">ledgerinsights.com</a> )	Bakong lowers transaction/transfer costs, supports remittances & micro-commerce — significant potential for micro-scale export MSMEs.
<b>Brunei</b>	Digital capabilities are relatively good (small population, focused national strategy).	digital economy master plan initiative; pilot fintech/regulatory sandboxes. ( <a href="http://mtic.gov.bn">mtic.gov.bn</a> )	The DE2025 masterplan promotes the integration of digital services (including payments). ( <a href="http://mtic.gov.bn">mtic.gov.bn</a> )	The Digital Economy Masterplan 2025 (DE2025) serves as a policy framework. ( <a href="http://mtic.gov.bn">mtic.gov.bn</a> )	Small scale but focused — digitalized MSMEs can more easily access international buyers through digital channels.
<b>Laos (Lao PDR)</b>	Digital capabilities are still developing; the government is developing strategies and	There haven't been many large-scale national blockchain implementations; the focus is on infrastructure	Digitalization and readiness roadmap for DEFA/ASEAN; payment initiatives under development. ( <a href="http://rtm.org.la">rtm.org.la</a> )	National Digital Economy Vision / strategy 2021–2030; DMA/assessments by UNDP/OECD/ERIA. ( <a href="http://undp.org">UNDP</a> )	Acceleration of basic digital capabilities (connectivity & literacy) is needed before MSMEs can leverage blockchain/CB payments for export.

	assessments (still in the readiness phase). ( <a href="#">UNDP</a> )	readiness and skills development. ( <a href="#">UNDP</a> )			
<b>Myanmar</b>	Digital capabilities and a fintech ecosystem exist (mobile money is popular), but political and regulatory conditions make stable inclusion difficult. ( <a href="#">GSMA</a> )	Several mobile money services (Wave Money) exist, but formal blockchain/cross-border implementation is limited due to macro-political conditions. ( <a href="#">GSMA</a> )	Mobile wallets (dominated by Wave Money) are expanding domestic inclusion, while cross-border payments remain limited/disrupted. ( <a href="#">GSMA</a> )	Digital payments efforts continue but are impacted by policy and security factors. ( <a href="#">myanmar.gov.m</a> )	MSMEs have the potential to leverage domestic mobile money; political and infrastructure barriers hinder opportunities for large-scale digital exports.

Source: processed data 2025

The table shows that the adoption of digital capabilities, blockchain, and cross-border digital payments in ASEAN varies significantly across countries. However, a general pattern emerges: countries with high levels of digital capabilities tend to be better able to leverage blockchain technology and cross-border payment systems to strengthen the export competitiveness of MSMEs.

### 1.1. Formulation of the problem

Based on the background and urgency of the research, the problem formulation that can be formulated is:

- 1) How does the level of blockchain transparency affect the digital capabilities of MSMEs in ASEAN countries?
- 2) How does the adoption of cross-border digital payments impact the digital capabilities of MSMEs?
- 3) How do digital capabilities affect international market access for MSMEs in the ASEAN region?
- 4) How do digital capabilities affect the export competitiveness of MSMEs?
- 5) Does blockchain transparency have a direct impact on international market access and MSME export competitiveness?
- 6) Does the adoption of cross-border digital payments have a direct impact on international market access and the export competitiveness of MSMEs?
- 7) Does digital capability mediate the influence of blockchain transparency on international market access and export competitiveness of MSMEs?
- 8) Does digital capability mediate the influence of cross-border digital payments on international market access and export competitiveness of MSMEs?

### 1.2. Research Purposes

In line with the problem formulation, the objectives of this research are to:

- 1) Analyzing the impact of blockchain transparency on the digital capabilities of MSMEs in ASEAN countries.
- 2) Analyzing the impact of cross-border digital payments on the digital capabilities of MSMEs.
- 3) Testing the influence of digital capabilities on MSMEs' international market access.
- 4) Testing the influence of digital capabilities on the export competitiveness of MSMEs.
- 5) Analyzing the direct impact of blockchain transparency on international market access and export competitiveness of MSMEs.

- 6) Testing the direct impact of cross-border digital payments on international market access and export competitiveness of MSMEs.
- 7) Testing the role of digital capabilities as a mediator of the influence of blockchain transparency on international market access and MSME export competitiveness.
- 8) Examining the role of digital capabilities as a mediator of the influence of cross-border digital payments on international market access and export competitiveness of MSMEs.

### 1.3. Research Hypothesis

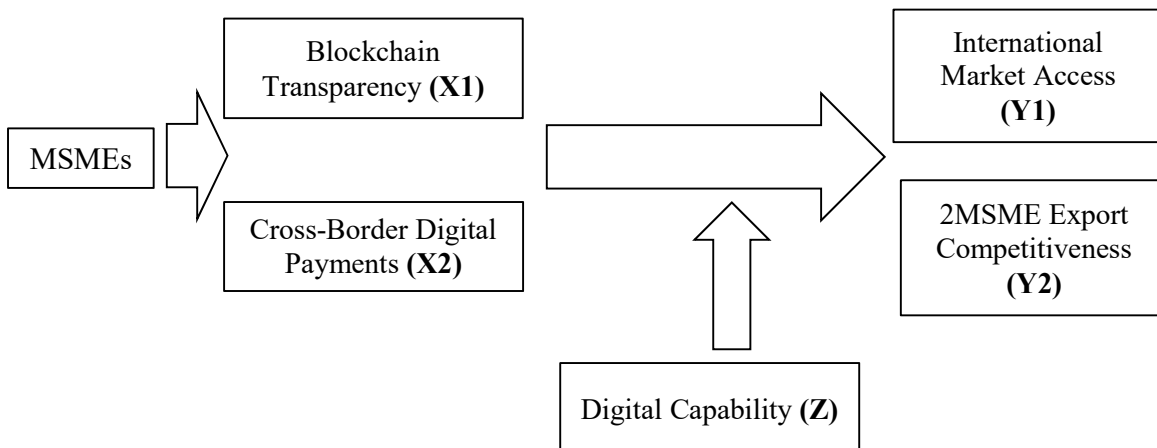
The following hypothesis is formulated:

- H1: Blockchain transparency has a positive effect on the digital capabilities of MSMEs.  
 H2: Adoption of cross-border digital payments has a positive effect on the digital capabilities of MSMEs.  
 H3: Digital capabilities have a positive effect on MSMEs' international market access.  
 H4: Digital capabilities have a positive effect on the export competitiveness of MSMEs.  
 H5: Blockchain transparency has a positive effect on MSMEs' international market access.  
 H6: Blockchain transparency has a positive effect on the export competitiveness of MSMEs.  
 H7: Cross-border digital payments have a positive effect on MSMEs' international market access.  
 H8: Cross-border digital payments have a positive effect on the export competitiveness of MSMEs.  
 H9: Digital capabilities mediate the influence of blockchain transparency on MSMEs' international market access.  
 H10: Digital capabilities mediate the effect of blockchain transparency on MSME export competitiveness.  
 H11: Digital capabilities mediate the influence of cross-border digital payments on MSMEs' international market access.  
 H12: Digital capabilities mediate the effect of cross-border digital payments on MSME export competitiveness .

### 1.4. Conceptual model

The following is a conceptual model of the research in the form of a structure of relationships between variables:

Figure 1 Conceptual Model



Source: 2025 data processing

By implementing Blockchain transparency and adopting digital payments, MSMEs will open up access to international markets and increase export competitiveness by mediating digital capabilities. With the following explanation (1) X1 and X2 influence Z, and Z influences Y1 and Y2, (2) X1 and X2 can also influence Y1 and Y2 directly, (3) Z is tested as a mediator in all of these relationships.

## 2. Literature Review

### 2.1 Blockchain Transparency (X1)

Blockchain is a decentralized record-keeping system that allows transactions to be recorded permanently, transparently, and immutably. Blockchain transparency plays a crucial role in reducing information asymmetry, increasing trust, and strengthening the integrity of global supply chains.

A study by Casino et al. (2019) showed that blockchain improves accountability in international trade through traceability and smart contracts. In the context of MSMEs, blockchain adoption can help build credibility in the eyes of global buyers (Chang & Chen, 2020).

In cross-border trade within ASEAN, transaction transparency is a key factor in strengthening international buyer trust, ultimately improving market access and export competitiveness. However, the capacity of MSMEs to utilize this technology is greatly influenced by their digital capabilities.

### 2.2 Cross-Border Digital Payments (X2)

Cross-border digital payments include the use of fintech platforms, QRIS Global, e-wallets, and real-time payment systems between countries. ASEAN is currently integrating digital payments through ASEAN Payments Connectivity (APC), enabling faster, cheaper, and more secure international transactions.

Research by Schmidt, Drexler, & Miro (2022) shows that cross-border payment efficiency can reduce transaction costs by up to 60% for MSMEs. Digital payment systems also improve access to capital and facilitate export transactions (World Bank, 2021).

However, the effectiveness of digital payments depends heavily on the digital capabilities of MSMEs in operating platforms, maintaining records, and maintaining cybersecurity.

### 2.3 Digital Capability (Z) as a Mediating Variable

Digital capability is the ability of MSMEs to utilize digital technology to improve business processes, including the ability to use applications, data management, analytics, and technology integration.

According to Teece (2018), digital capabilities are included in dynamic capabilities which help organizations adapt to technological changes.

In the context of blockchain and digital payments, digital capabilities become a critical mediator because:

- a. Technology does not provide a direct impact without the readiness of human resources and digital infrastructure of MSMEs.
- b. MSMEs with low digital capabilities are unable to operate blockchain systems and cross-border digital payments.
- c. Digital capabilities enable digital transformation so that technology provides maximum benefits (Khin & Ho, 2019).

### 2.4 International Market Access (Y1)

International market access reflects the ability of MSMEs to penetrate, enter, and maintain foreign markets through competitive products and services. Factors influencing international market access include market information, exporter credibility, logistics efficiency, and trading partner trust.

According to Cavusgil & Zou (1994), the use of technology plays a vital role in increasing international market readiness.

- a. Blockchain improves supply chain visibility,
- b. Digital payments speed up transactions,
- c. Digital capabilities enable MSMEs to better respond to global demand.

Studies in ASEAN show that digitalization increases the potential for MSMEs to enter international markets by up to 25% (ASEAN Secretariat, 2022).

## 2.5 MSME Export Competitiveness (Y2)

Export competitiveness is defined as the ability of MSMEs to produce quality products, be price competitive, and adapt to global standards. According to Porter (1990), competitiveness is influenced by productivity, efficiency, innovation, and technological capabilities.

In the context of digitalization:

- a. Blockchain increases product credibility (authenticity, security, quality).
- b. Digital payments speed up cash flow and reduce transaction risks.
- c. Digital capabilities enable MSMEs to achieve global marketing and operational efficiency.

Research in East Asia shows that MSMEs that have undergone digital transformation have experienced an increase in export performance of up to 40% (UNESCAP, 2021).

## 2.6 Relationship between variables in research

- a. Blockchain → Digital Capabilities → Market Access & Export Competitiveness  
Blockchain is only effective if MSMEs have the digital capabilities to manage transaction data, utilize smart contracts, and comply with international standards. Digital capabilities strengthen blockchain's impact on international market access.
- b. Cross-Border Digital Payment → Digital Capabilities → Market Access & Competitiveness  
Cross-border digital payments lower barriers to international transactions. However, their impact on market access and export competitiveness is only optimal when MSMEs have digital capabilities as the foundation of their operations.
- c. The Mediation Role of Digital Capabilities  
The literature shows that digital capability variables function as strategic mediators in the digital economic transformation of MSMEs (Zhang et al., 2023). This aligns with the proposed research model, where digital capability strengthens the relationship between blockchain technology and digital payments and export results.

## 3. Research Methodology

### 3.1 Research Design

This study uses a quantitative approach with an explanatory research method to explain the causal relationship between independent variables (blockchain transparency and cross-border digital payments), mediating variables (digital capabilities), and dependent variables (international market access and MSME export competitiveness).

The research design used is Partial Least Squares–Structural Equation Modeling (PLS-SEM) because:

- a. The research model is complex with many direct and mediated relationships.
- b. The data involves the perceptions of MSME actors and can be non-normal.
- c. PLS-SEM is suitable for testing theories in the context of digitalization of MSMEs which is still developing in ASEAN countries.

This research is cross-sectional, where data is collected over a certain period of time.

### 3.2 Population and Sample

#### Research Population

The population consists of export-oriented MSMEs in ASEAN countries including: Indonesia, Malaysia, Singapore, Thailand, Vietnam, the Philippines, Brunei Darussalam, Laos, Cambodia, and Myanmar.

The unit of analysis is the owner, manager, or staff of MSMEs involved in export activities and the use of digital technology.

#### Sampling Techniques

The sampling method uses purposive sampling with the following respondent criteria:

- a. MSMEs that have exported or have international trading partners.
- b. MSMEs that use at least one digital technology (digital payment, marketplace, ERP, blockchain-based traceability, or information system).

c. Respondents understand the digitalization process in business.

Sample Size

Referring to the 10-times rule in PLS-SEM, the minimum sample size is:

The largest number of indicators  $\times$  10. Since there are  $\pm$  21 indicators, the minimum sample size = 210 respondents.

To increase validity, the study targeted 300–500 respondents spread across ASEAN countries.

### 3.3 Research Variables

**Table 2: Research variables**

Variables	Indicator Code	Indicator
<b>Blockchain Transparency Level (X1)</b>	X1.1	Clarity of real-time transaction tracking
	X1.2	Availability of verifiable transaction data
	X1.3	Accuracy and consistency of information recording
	X1.4	Open accessibility of transaction history
	X1.5	Perception of security and integrity of transaction data
<b>Digital Payment Adoption (X2)</b>	X2.1	Frequency of use of cross-border payment systems
	X2.2	Convenience and speed of international transactions
	X2.3	Cross-border transaction cost efficiency
	X2.4	Compliance of digital payment features with export needs
<b>Digital Capabilities (Z)</b>	Z1	Ability to use operational digital technology
	Z2	Digital analytics capabilities for decision making
	Z3	Payment and blockchain technology literacy
	Z4	Investment and commitment in digital transformation
<b>International Market Access (Y1)</b>	Y1.1	Number of international business connections or networks
	Y1.2	Easy access to global trading platforms
	Y1.3	Frequency of export activities/international transactions
	Y1.4	Access to global market information
	Z2	Digital analytics capabilities for decision making
	Z3	Payment and blockchain technology literacy
	Z4	Investment and commitment in digital transformation
	Y1.4	Access to global market information
<b>International Market Access (Y1)</b>	Y1.1	Number of international business connections or networks
	Y1.2	Easy access to global trading platforms
	Y1.3	Frequency of export activities/international transactions
	Y1.4	Access to global market information

### 3.4 Data Analysis Techniques

Data analysis was performed using PLS-SEM with the help of SmartPLS 4 or WarpPLS through two main stages:

## 4. Result

### 4.1. Conclusion

The following are the results of validity and reliability.

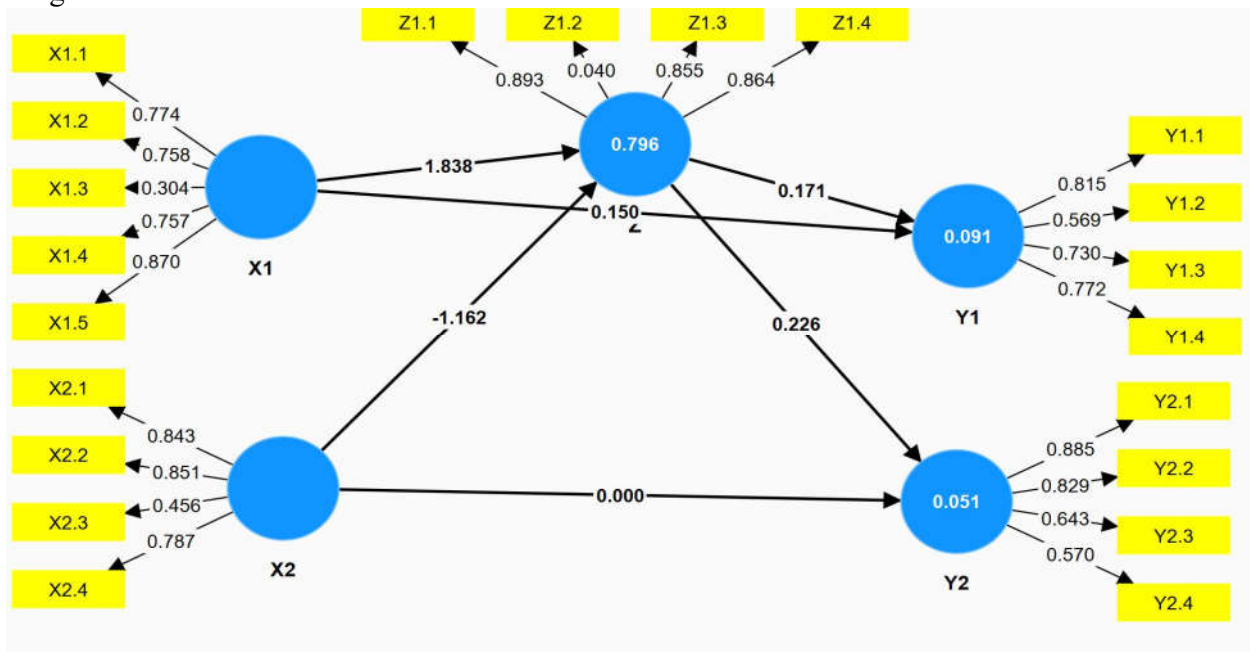
Table 3: validity and reliability

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
<b>X1</b>	0.789	0.935	0.833	0.519
<b>X2</b>	0.771	0.793	0.832	0.566
<b>Y1</b>	0.724	0.764	0.816	0.530
<b>Y2</b>	0.789	0.848	0.827	0.552
<b>Z</b>	0.702	0.918	0.803	0.569

Data source processed 2025

Based on the results of the outer model evaluation, all constructs have good reliability, indicated by Cronbach's Alpha and Composite Reliability values above the minimum limit of 0.70. Furthermore, all variables meet convergent validity with AVE values greater than 0.50. Thus, the constructs in the research model have met the requirements for use in structural testing (inner model).

Figure 2 Part Model



Data source processed 2025

### Interpretation of Structural Model Based on Hypothesis

#### 1) Effect of X1 → Z (H1)

Path coefficient value: 1.838 (strong positive)

This means that blockchain transparency (X1) has been proven to have a positive and very strong influence on the digital capabilities of MSMEs (Z).

H1 is supported

The higher the blockchain transparency, the more the digital capabilities of MSMEs will increase.

- 2) Effect of  $X2 \rightarrow Z$  (H2)  
 Path coefficient value:  $-1.162$  (strong negative)  
 This means that the adoption of cross-border digital payments ( $X2$ ) has a negative impact on digital capabilities ( $Z$ ).  
 H2 is not supported  
 High cross-border payments actually reduce digital capabilities.  
 This can happen if MSMEs are not ready, transaction costs are high, or digital infrastructure is not yet mature.
- 3) Effect of  $Z \rightarrow Y1$  (International market access) — H3  
 Path coefficient value:  $0.171$  (weak positive)  
 Digital capability ( $Z$ ) has a positive but weak influence on international market access ( $Y1$ ).  
 H3 is supported, but the effect is small.
- 4) The effect of  $Z \rightarrow Y2$  (Export competitiveness) — H4  
 Path coefficient value:  $0.226$  (moderately positive)  
 Digital capability ( $Z$ ) has a positive effect on the export competitiveness of MSMEs.  
 H4 is supported.  
 Digital capabilities help improve product quality and logistics efficiency, supporting exports.
- 5) Effect of  $X1 \rightarrow Y1$  (H5)  
 Path coefficient value:  $0.150$  (small positive)  
 Blockchain transparency ( $X1$ ) has a positive but small effect on international market access ( $Y1$ ).  
 H5 is supported although the effect is small.
- 6) Effect of  $X1 \rightarrow Y2$  (H6)  
 Path coefficient value:  $0.226$  (positive)  
 Blockchain transparency has a positive effect on export competitiveness ( $Y2$ ).  
 H6 is supported.
- 7) Effect of  $X2 \rightarrow Y1$  (H7)  
 Path coefficient value:  $0.000$  (no influence)  
 H7 is not supported.  
 Cross-border payments do not directly improve international market access.
- 8) Effect of  $X2 \rightarrow Y2$  (H8)  
 Path coefficient value:  $0.051$  (very small positive)  
 H8 is not supported (effect too small).
- 9) Mediation of  $Z$  on  $X1 \rightarrow Y1$  (H9)  
 Track:  
 $X1 \rightarrow Z = 1.838$  (strong)  
 $Z \rightarrow Y1 = 0.171$  (weak)  
 Indirect effect =  $1.838 \times 0.171 \approx 0.314$  positive  
 H9 supported  
 Digital capabilities positively mediate the influence of blockchain on international market access.
- 10) Mediation of  $Z$  on  $X1 \rightarrow Y2$  (H10)  
 Track:  
 $X1 \rightarrow Z = 1.838$   
 $Z \rightarrow Y2 = 0.226$   
 Indirect effect =  $1.838 \times 0.226 \approx 0.415$  positive  
 H10 supported  
 Digital capabilities are a powerful mediator in blockchain's influence on export competitiveness.
- 11) Mediation of  $Z$  on  $X2 \rightarrow Y1$  (H11)  
 Track:  
 $X2 \rightarrow Z = -1.162$  (negative)  
 $Z \rightarrow Y1 = 0.171$  (positive)

Indirect effect =  $-1.162 \times 0.171 = -0.198$  (negative)

H11 is not supported

Mediation is negative, causing cross-border payments to actually worsen market access through digital capabilities.

12) Mediation of Z on  $X2 \rightarrow Y2$  (H12)

Track:

$X2 \rightarrow Z = -1.162$

$Z \rightarrow Y2 = 0.226$

Indirect effect =  $-1.162 \times 0.226 \approx -0.262$  (negative)

H12 is not supported

Cross-border payments through digital capabilities reduce the competitiveness of exports

Table 4: Interpretation of Hypothesis

Hypothesis	Results	Explanation
H1	Supported	Blockchain $\rightarrow$ Digital capabilities (strong)
H2	Not supported	Cross-border payments $\rightarrow$ Digital capabilities (negative)
H3	Supported (weak)	Digital capabilities $\rightarrow$ Market access
H4	Supported	Digital capabilities $\rightarrow$ Export competitiveness
H5	Supported	Blockchain $\rightarrow$ Market access
H6	Supported	Blockchain $\rightarrow$ Export competitiveness
H7	Not supported	Cross-border payment $\rightarrow$ Market access
H8	Not supported	Cross-border payment $\rightarrow$ Competitiveness
H9	In-mediation	Z mediates $X1 \rightarrow Y1$
H10	In-mediation	Z mediates $X1 \rightarrow Y2$
H11	Not supported	Negative mediation
H12	Not supported	Negative mediation

Data source processed 2025

## Conclusion

The model shows that blockchain transparency is the most significant factor in improving:

- digital capabilities of MSMEs,
- international market access,
- and export competitiveness.

Conversely, the adoption of cross-border digital payments does not directly help MSMEs in ASEAN and may even reduce digital capabilities if MSMEs are not technologically ready and transaction costs remain high.

Digital capabilities have proven to be a crucial intermediary, particularly in strengthening blockchain's influence on market access and export competitiveness.

## 5. Finding and Discussion

### 5.1 Research Findings

This study analyzes the influence of Blockchain Transparency (X1) and Cross-Border Digital Payment Adoption (X2) on International Market Access (Y1) and MSME Export Competitiveness (Y2), with Digital Capability (Z) as a mediating variable. The model was tested using the Partial Least Squares (PLS-SEM) approach and yielded the following key findings:

- Blockchain Transparency Has a Strong Positive Impact on Digital Capabilities (H1 supported)  
The path coefficient value of  $X1 \rightarrow Z$  is 1.838, indicating that increased blockchain transparency significantly strengthens the digital capabilities of MSMEs. This indicates that information clarity, transaction auditability, and blockchain data security can increase MSME confidence in adopting digital systems.

2. Adoption of Cross-Border Digital Payments Negatively Impacts Digital Capabilities (H2 not supported)  
The path coefficient  $X2 \rightarrow Z$  is  $-1.162$ , indicating a strong negative relationship. This finding suggests that MSMEs in ASEAN countries that actively use cross-border payments face challenges such as high transaction costs, differing regulations across countries, and uneven technological capabilities.
3. Digital Capabilities Influence International Market Access and Export Competitiveness (H3 and H4 supported)  
 $Z \rightarrow Y1$ : 0.171 (positive but weak)  
 $Z \rightarrow Y2$ : 0.226 (medium positive)  
This demonstrates that digital capabilities play a strategic role, although their contribution to market access remains limited. Digital capabilities have a greater impact on export competitiveness due to their link to production efficiency, digital marketing, and supply chain management.
4. Blockchain Transparency Directly Impacts Y1 and Y2 (H5 and H6 supported)  
 $X1 \rightarrow Y1$ : 0.150  
 $X1 \rightarrow Y2$ : 0.226  
Blockchain provides transparency in supply chains and trade documentation, thereby increasing international market trust in ASEAN MSMEs.
5. Adoption of Cross-Border Payments Has No Impact on Y1 and Y2 (H7 and H8 are not supported)  
The coefficients are very small (0.00 and 0.051). This finding suggests that cross-border payments have not made a significant contribution because ASEAN MSMEs' digital infrastructure and literacy are suboptimal.
6. Digital Capabilities Become a Significant Mediator of Blockchain Influence (H9 and H10 supported)  
Positive and significant mediation occurs in:  
 $X1 \rightarrow Z \rightarrow Y1$   
 $X1 \rightarrow Z \rightarrow Y2$   
Digital capabilities strengthen the benefits of blockchain transparency in facilitating market expansion and enhancing export competitiveness.
7. Digital Capabilities Do Not Mediate the Effect of Cross-Border Payments (H11 and H12 not supported)  
Negative mediation shows that the utilization of cross-border payments without technological readiness actually reduces the effectiveness of MSME exports.

## 5.2 Discussion

### 1. Blockchain as a Transparency Instrument that Strengthens the Competitiveness of ASEAN MSMEs

The finding that blockchain significantly impacts digital capabilities and export competitiveness underscores the growing importance of this technology in cross-border trade. MSMEs need a system that can guarantee:

- 1) transaction security,
- 2) authenticity of export documents,
- 3) product traceability,
- 4) compliance with international standards.

This finding is in line with literature that suggests blockchain increases international consumer trust and improves supply chain quality.

### 2. Digital Infrastructure Gaps Hinder the Effectiveness of Cross-Border Payments

The negative result between  $X2$  and  $Z$  indicates that ASEAN MSMEs are not yet fully ready to integrate cross-border digital payments. Causal factors:

- 1) differences in monetary regulation ;
- 2) international transaction costs are still high;

- 3) uneven distribution of e-KYC and AML systems;
- 4) unpreparedness of MSMEs in cyber security.

This finding reinforces previous studies that emphasize the need for harmonization of regional standards (e.g., QRIS across ASEAN).

### 3. Digital Capabilities Are the Key to Strengthening MSME Exports

Digital capabilities act as a strategic enabler for MSMEs, particularly in:

- 1) global digital marketing,
- 2) utilization of international B2B platforms,
- 3) data-driven supply chain management,
- 4) automation of production processes to increase efficiency.

Although its contribution to market access (Y1) is still weak, this may be due to:

- 1) logistical obstacles,
- 2) differences in destination country standards,
- 3) limited brand awareness of ASEAN MSMEs in the global market.

### 4. Cross-Border Payments Are Not Yet a Determining Factor in Market Access and Export Competitiveness

Findings that do not support H7 and H8 indicate that the availability of cross-border payments is not a major factor in increasing exports. MSMEs prioritize:

- 1) logistics costs,
- 2) product quality,
- 3) export certification,
- 4) currency stability.

So cross-border payments become a supporter, not the main driver.

### 5. Digital Capabilities Mediation Strengthens Blockchain's Role, But Weakens Cross-Border Payments

Positive mediation in the  $X1 \rightarrow Y$  relationship shows that blockchain only provides full impact if MSMEs have good digital competencies.

In contrast, negative mediation on  $X2 \rightarrow Y$  proves that limited digital capabilities make cross-border payments less effective.

These findings underscore the importance of:

- 1) digital training,
- 2) improving ICT infrastructure,
- 3) standardization of digital systems between ASEAN countries.

### 6. Policy Implications for ASEAN

The research results indicate an urgent need for:

- 1) Building a regional blockchain ecosystem to support ASEAN digital trade.
- 2) Standardization of cross-border payment systems, including QR code unification and fintech regulations.
- 3) Improving the digital capabilities of MSMEs through training, digital talent development, and technology mentoring.
- 4) Cross-border collaboration in developing an integrated ASEAN digital trade platform.

### Conclusion

Overall, this study confirms that:

- 1) Blockchain is a strategic factor that directly and indirectly strengthens the export capabilities of MSMEs.
- 2) Cross-border digital payments are not yet optimal and do not have a significant impact.
- 3) Digital capability is a key variable that determines the success of ASEAN MSMEs' digital transformation in entering the international market.

## 6. Conclusion and recommendations

### 6.1 Conclusion

This study examines the role of Digital Capability as a strategic mediator in the relationship between Blockchain Transparency and Cross-Border Digital Payments on International Market Access and MSME Export Competitiveness in the ASEAN region. Based on the PLS-SEM analysis, the following key points can be concluded:

- 1) Blockchain transparency has been shown to have significant direct and indirect impacts. Blockchain technology strengthens the digital capabilities of MSMEs (Z), directly enhancing their ability to enter international markets (Y1) and strengthening export competitiveness (Y2). The indirect impact through the mediation of digital capabilities is also significant. This suggests that the more transparent and traceable MSME transaction processes are, the greater their opportunities to penetrate global markets.
- 2) Cross-Border Digital Payment Adoption does not show any significant positive impact. Research shows that cross-border payments have not optimally contributed to improving digital capabilities, international market access, and export competitiveness. This indicates persistent technical barriers, high costs, differing regulations, and uneven digital readiness among MSMEs across ASEAN.
- 3) Digital Capability is a key variable (strategic enabler). Digital capability has a positive effect on international market access and export competitiveness, although its effect on market access is relatively weak. This variable is a significant mediator, strengthening the influence of blockchain transparency, but it cannot mediate the relationship between cross-border payment adoption and adoption.
- 4) The research model shows that ASEAN MSMEs are still in the digital transition stage. MSMEs have begun utilizing blockchain and some have begun adopting cross-border payments. However, their effectiveness depends heavily on digital readiness—in terms of literacy, infrastructure, and government policy support.
- 5) Digital collaboration and harmonization between ASEAN countries is essential. Differences in regulations, technological readiness, and levels of digitalization between countries are key challenges hindering the full benefits of blockchain technology and cross-border payments.  
Energy-efficient AI cannot be achieved without compatible hardware platforms. Specialized accelerators such as GPUs, TPUs, and emerging neuromorphic chips need to be integrated with telecom infrastructure to reduce inference latency and power usage. Additionally, edge computing nodes must be provisioned with energy-aware processors to handle AI tasks locally, avoiding excessive cloud dependency.

### 6.2 Recommendations

Based on these findings, this study provides several recommendations aimed at the government, ASEAN policymakers, financial institutions, MSMEs, and the digital ecosystem.

- 1) Strengthening the Blockchain Ecosystem for ASEAN MSMEs
  - a. The government needs to develop blockchain standards for export trade.
  - b. The application of blockchain in supply chain, product certification, and logistics management needs to be accelerated.
  - c. Cross-border collaboration is needed for blockchain to be used in an integrated manner across ASEAN.
- 2) Harmonization of Cross-Border Digital Payment Systems
  - a. ASEAN needs to accelerate cross-border QR payment integration and expand initiatives such as the Inter-Country QRIS.
  - b. Simplification of regulations related to AML, KYC, and cross-border transactions.
  - c. Reducing international transaction costs to make MSMEs more competitive.
- 3) Improving MSMEs' Digital Capabilities Systematically and Sustainably

Programs that need to be strengthened include:

- a. digital literacy, cybersecurity, and data analytics training;
  - b. assistance in adopting digital technology for export MSMEs;
  - c. digitalization incentives such as cloud computing subsidies, digital marketing, and global e-commerce platforms.
- 4) Building a More Equitable Digital and Logistics Infrastructure in ASEAN
- a. Strengthening internet networks, smart logistics, and real-time tracking systems.
  - b. Government support through digital export centers in each country.
  - c. Blockchain-based warehouse, cold chain, and cross-border tracking technology enhancements.
- 5) Promoting Regional Collaboration in Digital Trade
- a. ASEAN needs to build a blockchain-based integrated digital trade platform.
  - b. The ASEAN MSME community can be strengthened through joint training forums, product standardization, and regional incubation programs.
6. Further Research
- Further research could:
- a. expanding variables such as digital literacy, infrastructure readiness, or government policies;
  - b. using mixed methods to obtain a more in-depth picture;
  - c. compare results between ASEAN countries in more detail.

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