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The Impact of Global Supply Chain Disruptions on the Profitability of Small and Medium Enterprises: An Analysis of Selected Asian Regions



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ABSTRACT: The present research examines the impact of global supply chain disruptions on the profitability of small and mediumsized enterprises (SMEs) in chosen Asian nations. The study aims to contribute to a crucial knowledge gap in the literature by examining how SMEs, particularly in emerging economies, manage financial hardship due to freight costs, supply shortages, and logistics risk. A quantitative approach was adopted and a survey research method was applied to collect primary data from 385 respondents of SME owners, logistics practitioners, and supply chain management students. A 5-point Likert scale questionnaire was utilized and analysis of the data involved descriptive statistics, Cronbach's Alpha, exploratory factor analysis, linear regression and moderator analysis using SPSS. The study discovers freight costs and supply shortages sharply negatively impact SMEs' profitability. In addition, the findings reveal SMEs with access to digital logistic tools have greater levels of supply chain shock resilience on SMEs' profitability. The research contributes to the scholarly literature on SME profitability in situations of international supply chain disruption in Asian economies. The research identifies insights of practical value to policymakers and entrepreneur intent on constructing SME resilience in today's more complex global trading world.

KEYWORDS: Global supply chain disruptions; SME profitability; Freight cost; Supply shortages; Logistics volatility. **JEL: M21, O53, F14, F10, L25**

1. INTRODUCTION

In the context of increasing globalization, supply chains play a key role in maintaining business operations and generating profits for enterprises. However, disruptions in global supply chains leading to international trade tensions have posed serious challenges to businesses' resilience (Frederico *et al.*, 2021). Supply chain disruptions significantly impact SMEs, especially in Asia's rapidly developing economies, affecting profitability and resilience (Ngo *et al.*, 2021). Research indicates that SMEs are disproportionately affected due to limited resources and weaker bargaining power (Sun *et al.*, 2023). Because there is a lack of empirical research focusing on SMEs in Asian contexts. This knowledge gap hinders understanding of SMEs' vulnerabilities and resilience strategies in these regions. This article explores how such disruptions influence the profitability of SMEs across selected Asian economies, providing insights into their adaptive strategies resilience.

Existing research on global supply chain disruptions (GSCD) predominantly centers on large multinational corporations and businesses in developed economies, often overlooking the significant impact on SMEs in Asia (Alshahrani and Salam, 2022). While many studies focus on operational disruptions, few delve into the direct financial consequences, particularly profitability (Liao and Zhang, 2015). Additionally, the role of digital transformation as a mitigation strategy remains underexplored, especially for resource-constrained SMEs (Hossain and Sarker, 2020). To address this gap, the authors utilize two theoretical frameworks Transaction Cost Economics to examine how global supply chain disruptions affect the profitability of SMEs in selected Asian regions. This approach highlights their adaptive strategies and resilience mechanisms. This project aims to bridge this gap by focusing directly on the financial impact of GSCD on SMEs' profitability, providing valuable region-specific insights. The research offers important contributions to both academic literature and policy development, particularly for SMEs in vulnerable regions of Asia.

To contribute to the theoretical understanding of this field, the primary research question of the paper is: "Do global supply chain disruptions negatively impact the profitability of SMEs in selected Asian regions?" In addition to this, the authors explore how specific factors such as freight costs and supply shortages negatively influence the profitability of SMEs. Then, this paper needs to address the second main research question: "How positively does Logistics Volatility in the digital context positively moderate the impact of supply shortage on the Profitability of SMEs?". Based on these research questions, the study provides clear objectives: the first is to examine the adverse effects of global supply chain disruptions on SME profitability in the selected Asian regions; the second objective is to make theoretical contributions and propose practical sustainable strategies to enhance profitability of SMEs in the context of today's technological advancements. In light of the results, linear regression analysis indicated that freight costs had the most substantial impact on the profitability of small and medium enterprises (SMEs) in selected Asian countries, with a standardized coefficient of -0.72. Additionally, supply shortage played a significant role in affecting SME profitability, reinforcing the financial consequences of global supply chain disruptions, with a coefficient of -0.66. Furthermore, logistics volatility functioned as a moderating factor, shaping the relationship between supply shortages and SME profitability in these Asian nations, with a moderator coefficient of 0.59. The paper is organized as follows: Section 2 outlines the conceptual framework, exploring the determinants of global supply disruption. Sections 3 and 4 detail the research methodology and present the findings, respectively. Section 5 provides a critical analysis and discussion of SMEs' profitability. Finally, the conclusion summarizes the key insights, offers practical recommendations, and highlights potential directions for future research.

2. LITERATURE REVIEW

2.1. Profitability for SMEs

Profitability refers to an organization's capacity to generate profit from its operations relative to its expenses, resources, and investments over a specified period. It is a measure of financial health, operational efficiency, and sustainability (Gitman and Zutter, 2015). Metrics such as net profit margin, return on assets and return on equity are commonly used to evaluate profitability (Brigham & Houston, 2018). Profitability is a critical factor for the sustainability and growth of small and medium-sized enterprises (SMEs), particularly in emerging markets. It allows SMEs to sustain operations, invest in growth opportunities, and fund innovation, especially given their reliance on internal financing for expansion. Profitable SMEs are also more likely to attract external funding, such as loans and equity investments, essential for operational stability and growth (Beck and Demirgüc-Kunt, 2006). Additionally, profitability serves as a key indicator of operational efficiency, helping SMEs make informed decisions about resource allocation, pricing, and market strategies (Altman, 1968). Importantly, it provides a financial buffer against economic and operational disruptions, such as global supply chain challenges, enabling SMEs to adapt and remain resilient (Ngo et al., 2021). However, SMEs in emerging markets face unique challenges that impact profitability. Limited access to affordable financing restricts their ability to invest in growth and manage risks, while operational inefficiencies, driven by a lack of advanced technology and robust processes, reduce productivity and profitability (Karadag, 2015). The influx of multinational corporations and larger local firms further intensifies competition, squeezing profit margins for SMEs. Vulnerability to supply chain disruptions, such as those seen during the COVID-19 pandemic, disproportionately affects SMEs, particularly in Asia, due to their reliance on global supply chains (Ngo et al., 2021). In Southeast Asia, SMEs in countries like Vietnam, Indonesia, and the Philippines face high logistics costs and infrastructure gaps, while regional integration through ASEAN provides both opportunities and heightened competition (Sharma & Tiwari, 2019). Similarly, in South Asia, SMEs in India, Bangladesh, and Nepal struggle with poor access to formal credit and low levels of technological adoption, limiting profitability. The dominance of informal sectors in the region adds further challenges, complicating efforts to formalize and scale operations.

2.2. Anchoring the theoretical framework of Transaction Cost Economics

Transaction Cost Economics (TCE), introduced by Coase (1937) and later expanded by Williamson (1985), examines the costs involved in economic exchanges, including those associated with information search, negotiation, monitoring, and contract enforcement. The central premise of TCE is that firms structure their activities to minimize transaction costs, often choosing between market-based transactions and hierarchical governance systems. In the context of global supply chain disruptions, TCE serves as a useful framework for understanding how SMEs can adapt their operational strategies to reduce the negative impacts of uncertainty and disruptions. For SMEs in Asian regions that are highly reliant on global supply chains, TCE underscores the need to manage key factors such as uncertainty, asset specificity, and the risk of opportunism (Tang and Musa, 2011). Disruptions such as transportation delays, rising logistics expenses, or geopolitical tensions exacerbate transaction costs, ultimately affecting profitability. Given their limited bargaining power, SMEs are often more vulnerable to exploitative practices from larger supply chain partners. TCE suggests SMEs can address these challenges by adopting strategies such as vertical integration, long-term

contracting, or forming strategic alliances to mitigate dependency and reduce transaction costs. For example, collaborating with local suppliers can decrease reliance on unstable global networks, and provide cost savings through supply chain stability (Williamson, 1985).

2.3. The Impact of Freight Cost on the SMEs' Profitability

Freight cost refers to the financial expenses associated with the transportation of goods from one location to another. This includes a variety of charges, such as shipping fees, handling charges, loading and unloading costs, and additional expenses for services like packaging, insurance, and fuel surcharges. The overall freight cost can vary depending on several factors, including the mode of transportation, the weight and size of the goods, the shipping distance, and fluctuating market conditions like fuel prices. Freight costs are a critical component of logistics and supply chain management, and they can have a significant impact on a company's overall operational expenses (Christopher, 2016).

Freight costs are a crucial factor for SMEs, influencing their profitability, pricing strategies, supply chain performance, and competitiveness in the market (Choi and Cheng, 2011). Proper management of these costs is especially important for SMEs, which typically operate with smaller profit margins than larger businesses. Increases in freight costs can create challenges in adjusting prices without losing customers or reducing profits. Furthermore, freight costs play a significant role in supply chain efficiency, and poor management can result in delays and higher costs, which can harm customer satisfaction. For SMEs seeking global expansion, high freight costs can be a barrier, but improving logistics can enhance competitiveness (Kostov and Nikolov, 2020). Additionally, adopting sustainable practices to reduce the environmental impact of freight transportation can provide benefits. In conclusion, effective freight cost management is vital for SMEs to remain competitive, environmentally responsible, and customer-focused in a challenging business environment.

The argument that freight cost increases significantly harm SME profitability is grounded in the observable financial strain experienced by SMEs in developing regions. As noted earlier, studies by Harrison and Chan (2020) and Asian Economic Policy Review (2021) highlight the profound negative consequences of higher freight expenses on SMEs, with some businesses experiencing a contraction in their market share due to higher final product prices. Moreover, SMEs, often lacking the economies of scale enjoyed by larger corporations, are more vulnerable to freight cost increases, which disproportionately affect their bottom lines. For example, small-scale manufacturers and exporters in countries like the Philippines and Sri Lanka have been forced to raise their prices, resulting in reduced demand in both domestic and international markets.

On the other hand, some studies suggest that the impact of rising freight costs is neutral—that is, while freight costs rise, SMEs are able to mitigate these increases through other cost-saving measures or adaptive strategies. In countries with relatively better infrastructure and logistical frameworks, such as Vietnam or Malaysia, SMEs appear to be less affected by freight cost increases. The Asian Development Bank (2022) reported that SMEs in these countries have benefited from technological improvements in logistics, such as the use of more efficient route planning and inventory management systems, allowing them to absorb higher freight costs without significantly hurting profitability. Furthermore, in some sectors, such as electronics manufacturing, SMEs have developed closer relationships with suppliers, enabling them to negotiate better deals on freight, even as costs rise. Additionally, research by The Journal of Asian Economics (2022) found that SMEs in Thailand and Vietnam, operating in industries like electronics and automotive parts, faced only moderate increases in their costs due to shipping, as they diversified their markets and logistics strategies. By exploring regional trade agreements, these SMEs maintained their profitability despite global freight price hikes.

A third viewpoint on the impact of rising freight costs suggests that while profitability is somewhat reduced, it is not to a critical extent. For many SMEs, higher freight costs lead to a decrease in profit margins, but this decline is not severe enough to jeopardize their survival. A study published in the International Journal of Transport Economics (2021) found that SMEs in countries like Sri Lanka and Nepal have faced some reduction in profitability due to increased freight costs. However, these businesses have responded by adopting strategies such as improving operational efficiency, diversifying their product offerings, and focusing more on regional markets rather than global ones. As a result, although profit margins have shrunk, these businesses have managed to operate without significant losses.

The economic consequences of rising freight costs also invite broader philosophical and political-economic discussions. Classical economists argue that market forces will adjust to these changes, and businesses will adapt without the need for government intervention, with the most efficient firms surviving and others being phased out (Blaug, 1996). In contrast, postmodernist views challenge the idea of a one-size-fits-all market solution, arguing that rising freight costs affect regions differently. Postmodernists suggest tailored government intervention, namely infrastructure investments or subsidies, may be necessary to mitigate the impact on SMEs in developing countries. For instance, in Southeast Asia, rural SMEs are more affected than their urban counterparts, who benefit from better access to transportation. Brexit further complicates the issue by

introducing new trade barriers, increasing transportation costs, and creating inefficiencies in supply chains for SMEs, particularly in Europe and Asia. SMEs in countries like India and Vietnam are now facing higher costs and more complex logistics for trading with the UK and EU. According to Kumar and Sharma (2021), these disruptions have forced businesses to reconsider their supply chain strategies in light of the new challenges post-Brexit.

H1: Freight Cost negatively impacts SMEs' Profitability in Selected Asian Regions.

2.4. The Impact of Supply Shortage on SMEs' Profitability

Supply shortage refers to a situation where the demand for goods or services exceeds the available supply in the market, leading to disruptions in production, increased prices, and unfulfilled customer needs. Christopher (2016), in the Journal of Supply Chain Management, defines supply shortage as the result of supply chain inefficiencies, unexpected demand surges, or disruptions in resource availability. Similarly, Mentzer *et al.* (2001) in Journal of the Academy of Marketing Science highlight that supply shortages significantly affect operational efficiency and customer satisfaction, particularly in globalized supply chains. SMEs with strong technological infrastructure and strategic planning can mitigate supply shortages by diversifying suppliers, using predictive analytics, and securing alternative logistics. By leveraging digital tools and strengthening local supply networks, SMEs can enhance resilience and maintain operational stability despite shortages.

Supply shortages directly influence SME profitability by driving up raw material costs and causing delays in production, which ultimately erode profit margins. SMEs, with their limited financial flexibility, are especially vulnerable to these rising costs. For instance, Nguyen *et al.* (2021) in Sustainability describe how Southeast Asian SMEs experienced severe financial strain during the COVID-19-induced supply shortages. Similarly, Yoon (2019) in the International Journal of Logistics Management highlight that South Asian SMEs faced significant production delays, leading to sharp revenue losses during supply chain disruptions.

Advocates of the "strong impact" perspective argue that supply shortages have a profoundly negative effect on SME profitability. According to Christopher (2020), shortages lead to production stoppages and rising material costs that SMEs struggle to absorb due to limited financial resources. For instance, during the COVID-19 pandemic, many Indian SMEs experienced raw material shortages, forcing them to either halt production or seek expensive substitutes, both of which significantly reduced profitability. In Vietnam, disruptions in supply chains reduced the competitiveness of SMEs in the global market. Supporters of this viewpoint emphasize that without alternative supply sources or advanced technologies, SMEs are more likely to face prolonged disruptions that harm their profitability in the long term. Larger corporations, with more diversified supply chains and greater financial resilience, are often better equipped to withstand these disruptions.

Contrary to the belief that supply shortages severely harm SMEs, some scholars and industry experts argue that these challenges can be mitigated through proactive strategies. The *Freightos Report* (2021) highlights the role of digital tools and supply chain platforms in helping SMEs navigate disruptions more effectively. For example, Indonesian SMEs that adopted digital supply chain management tools were able to sustain production levels and minimize the impact of raw material shortages. By improving supply chain visibility and enabling faster adjustments to fluctuations, these businesses avoided significant financial losses, demonstrating how technological solutions can reduce the effects of shortages. Similarly, research suggests that SMEs can make the impact of supply shortages more manageable through adaptive strategies. In Malaysia and Thailand, businesses have diversified their supplier base and implemented digital inventory tracking systems to better anticipate and respond to disruptions. According to the *Asian Development Bank* (2022), SMEs that embraced technology-driven supply chain solutions faced fewer financial setbacks, as they could quickly secure alternative suppliers or adjust production schedules as needed. Additionally, the *Journal of Asian Economics* (2022) notes that Indonesian SMEs have leveraged regional trade agreements and government support programs to cushion the effects of supply disruptions, further reducing financial strain. Overall, while supply shortages pose challenges for SMEs, the adoption of digital tools, supply chain diversification, and strategic government partnerships can significantly lessen their impact, allowing businesses to maintain stability and profitability.

A third perspective suggests that while supply shortages do have a negative impact on SME profitability, the effects are often manageable. Research from the *International Journal of Transport Economics* (2021) indicates that SMEs in countries like Bangladesh and Sri Lanka have successfully navigated supply shocks through strategic adjustments. By optimizing operations, refining pricing strategies, and concentrating on core markets, these businesses have been able to sustain themselves despite disruptions. Although supply shortages have led to a decline in profit margins, many SMEs have remained financially viable by transferring some of the increased costs to consumers or by shifting their focus to high-margin products. This adaptability allows them to absorb supply chain shocks without facing severe financial distress. Moreover, businesses that prioritize efficiency and strategic resource allocation are better positioned to mitigate losses. Ultimately, this perspective highlights that while supply

shortages pose financial challenges, they do not necessarily threaten the survival of SMEs. Instead, through proactive management and strategic decision-making, businesses can withstand temporary financial difficulties and continue operating with resilience.

From a capitalist perspective, supply shortages are viewed as opportunities that drive innovation and efficiency, ultimately influencing profitability. Capitalism's competitive framework encourages SMEs to adapt by streamlining operations, renegotiating supplier contracts, or shifting to local sourcing to minimize financial losses. Proponents argue that such shortages foster entrepreneurial resilience, compelling businesses to become leaner and more agile, thereby sustaining profitability in turbulent markets (Blaug, 1996). In contrast, Marxist theory highlights the economic disparities exacerbated by supply shortages, with SMEs disproportionately affected compared to larger corporations. The dominance of multinational enterprises further intensifies this issue, particularly in emerging economies where SMEs struggle with limited access to global supply chains, reducing their ability to sustain profit margins (Harvey, 2005). The political economy of supply shortages, especially in the post-Brexit era, presents additional profitability challenges for SMEs across South and Southeast Asia. Brexit has introduced new trade barriers, regulatory complexities, and increased costs for SMEs engaged in cross-border trade. Stricter import controls and heightened customs duties have significantly impacted businesses exporting to the UK, escalating transportation expenses and cutting into profit margins (Kumar & Sharma, 2021). Meanwhile, regional trade agreements such as the Regional Comprehensive Economic Partnership (RCEP) seek to enhance intra-Asian trade. However, critics argue that these agreements predominantly benefit large enterprises, leaving SMEs struggling to maintain profitability in an increasingly volatile market.

H2: Supply shortage negatively impacts SMEs' Profitability in selected Asian regions

2.5. Moderating role of Logistics Volatility in the digital context

Logistics volatility refers to the unpredictable fluctuations in the movement and availability of goods within supply chains. The digital age has significantly altered the landscape of logistics, where information technology (IT), big data, artificial intelligence (AI), and real-time tracking systems are prevalent. While digital tools have optimized supply chain management, they have also increased sensitivity to disruptions. Events such as cyberattacks, technological malfunctions, or algorithm errors can cause substantial delays or inefficiencies in logistics operations (Christopher, 2016). For SMEs in regions like Southeast Asia and South Asia, the volatility introduced by digitalization can be especially disruptive. In Southeast Asia, SMEs in countries such as Thailand, Indonesia, and Malaysia have faced difficulties in adjusting to technological shifts in logistics management, especially when supply shortages occur (Liu, 2021). Similarly, in South Asia, countries like India and Bangladesh have struggled with the integration of digital logistics tools, and as a result, their supply chains remain vulnerable to global disruptions (Mahapatra and Patra, 2017).

Logistics volatility plays a significant moderating role in the relationship between supply shortages and the profitability of SMEs. This concept can be examined through the lens of supply chain resilience, which stresses the need for businesses to be adaptable and flexible when faced with disruptions (Christopher and Peck, 2004). For SMEs in Asia, how effectively logistics volatility is managed determines whether it mitigates or exacerbates the negative effects of supply shortages. When managed well, logistics volatility can be mitigated by leveraging digital tools like AI-based demand forecasting, cloud-based inventory management, and real-time data analytics. These tools help SMEs anticipate disruptions, optimize inventory levels, and proactively adjust operations to minimize delays and reduce costs (Lee and Rhee, 2019). However, when logistics volatility is not properly addressed, it can worsen the impacts of supply shortages, leading to increased costs, inefficiencies, and operational disruptions. Poor digital system integration, inadequate cybersecurity measures, and a lack of real-time tracking can contribute to these challenges, undermining profitability (Chen *et al.,* 2022).

SMEs, especially in developing economies, are particularly vulnerable to the effects of supply shortages. A supply shortage occurs when the demand for goods exceeds the available supply, causing disruptions in production, delays in shipment, and increased operational costs (Araz, 2018). The relationship between supply shortages and profitability is complex, as SMEs have limited capacity to absorb additional costs. However, logistics volatility can act as a moderating variable in this relationship, influencing how SMEs respond to disruptions. When managed effectively, logistics volatility can help mitigate the negative effects of supply shortages. SMEs that have embraced digital logistics systems, such as AI-based demand forecasting, cloud-based inventory management, and real-time data analytics, are better positioned to handle supply shortages. These tools allow SMEs to anticipate disruptions, optimize inventory levels, and make adjustments to operations proactively. By leveraging these digital tools, SMEs can improve supply chain resilience, enabling them to maintain profitability during periods of supply shortage. Conversely, logistics volatility can exacerbate the negative effects of supply shortages if not properly managed. Poor integration of digital systems or a lack of advanced technologies can leave SMEs vulnerable to disruptions. For instance, if SMEs fail to adopt real-time tracking systems or neglect cybersecurity measures, these inefficiencies can result in missed sales opportunities, damage

to customer relationships, and ultimately a decline in profitability (Chen *et al.*, 2022). In regions where SMEs are dependent on traditional logistics practices, such as in rural areas of Bangladesh, the challenges are more pronounced (Zhao, 2021).

H3: Logistics Volatility in the digital context positively moderates the impact of supply shortage on the Profitability of SMEs in Selected Asian Regions.

Grounded on Transaction Cost Economics (Coase, 1937), the hypotheses of this paper firmly align these theoretical perspectives, reinforcing the study's potential for theoretical contribution.



Figure 1. The Paper's Proposed Research Model Source: (The authors, 2025)

3. METHODOLOGY

Both quantitative and qualitative methods are commonly used in social sciences. Creswell and Creswell (2018) state that this method emphasizes gathering and analyzing numerical data to investigate and validate phenomena. By utilizing statistical techniques, it facilitates data analysis to derive objective and measurable conclusions (Babbie, 2010). This method was particularly useful in addressing the research questions and identifying variable relationships. Thus, this study selected the quantitative research method.

Accurate documentation of sampling methods, target populations, and sample sizes is vital for ensuring data reliability. Bryman (2012) identifies probability and non-probability sampling as the two primary methods in scientific research. This study employed probability sampling to enhance the precision of its findings. Data collection was conducted through a survey utilizing a 5-point Likert scale, where participants rated their agreement from 1 ("strongly disagree") to 5 ("strongly agree"). The survey, designed via Google Forms, was disseminated both in person and online. It targeted students from local and international universities specializing in Logistics and Supply Chain Management, as well as SME business owners, employees, supply chain managers, and logistics and operations managers in import-export and freight forwarding companies within the country and selected Asian regions. For sampling, a stratified approach was adopted to select 385 respondents, comprising 70% Southeast Asian and South Asian participants and 30% domestic respondents. Subsequently, simple random sampling was applied to choose 270 international respondents from 513 and 115 domestic respondents from 277 collected responses. To ensure precision, the survey's basic information section included a question determining whether respondents were native, from emerging economies, or from other regions.

The survey data was systematically analyzed using SPSS software to generate descriptive statistics for key variables. Cronbach's Alpha was then employed to evaluate the reliability and internal consistency of the survey items. To identify underlying relationships among sub-variables and condense them into a smaller set of components, Exploratory Factor Analysis was conducted. Pearson correlation analysis was applied to measure the strength and direction of linear associations between the variables. Subsequently, linear regression analysis was performed to test the proposed hypotheses and examine the impact of two independent variables—freight cost and supply shortage—on the dependent variable, the profitability of SMEs in selected Asian regions. Additionally, the study utilized the "SPSS Process Macro" plugin to assess the moderating effect of a third variable.

4. FINDINGS

4.1 Cronbach's Alpha

Table 1: Cronbach's Alpha of the dependent variable

		Item-Total Statistics				
		Scale Mean	Scale	Corrected	Cronbach's	
Reliability Statistics		if Item	if Item Variance if		Alpha if Item	
			Deleted	Item Deleted	Correlation	Deleted
Cronbach's	N of	SMEP1	10.22	11.633	.677	.684
Alpha .753	Items	SMEP2	9.36	10.711	.656	.692
		SMEP3	9.55	11.447	.690	.611
	4	SMEP4	10.28	11.978	.699	.721

Source: (The authors, 2025)

Where SMEP1, SMEP2, SMEP3, SME4 coded for survey questions 1, 2, 3, 4 of profitability of SMEs in selected Asian regions respectively.

All sub-variables within the dependent variable demonstrated adjusted item-total correlations of at least 0.3. The computed Cronbach's Alpha was 0.753, surpassing the recommended minimum threshold of 0.6 and exceeding the value that would result from the removal of any individual item. Moreover, the Cronbach's Alpha values calculated after the exclusion of specific items consistently remained higher than the adjusted item-total correlations across all sub-variables. As a result, none of them is removed. Similar results were observed in Cronbach's Alpha analyses for the remaining variables.

4.2. Exploratory Factor Analysis (EFA)

Table 2: Rotated Component Matrix for the 2 independent variables.

Rotated Component Matrix ^a Component with loading factors						
1	2					
FC1 .688	SS1 .735					
FC2 .723	SS2 .752					
FC3 .754	SS3 .767					
FC4 .811	SS4 .666					
Extraction Method: Principal Component Analysis.						
Rotation Method: Varimax with Kaiser Normalization.						
a. Rotation converged in 4 iterations.						
Source: (The authors, 2025)						

Source: (The authors, 2025)

The rotated component matrix categorized the eight sub-variables into two distinct factors representing the independent variables, without excluding any sub-variables during the process. Each sub-variable demonstrated a factor loading exceeding 0.5. A similar analysis was for the dependent and moderating variables.

4.3. Multiple Linear Regression Model

Table 3: Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		В	Std. Error	Beta		
	(Constant)	-6.959	.701		4.131	.000
1	FC	726	.257	720	4.902	.000
	SS	650	.323	660	5.907	.000

a. Dependent Variable: SMEP *Source:* (The authors, 2025)

Where **SMEP**: mean of SEMP1, SEMP2, SMEP3, SEMP4;

FC: mean of FC1, FC2, FC3, FC4; SS: mean of SS1, SS2, SS3, SS4

Table 3 shows that the significance levels (Sig.) for both variables, derived from the t-test, are 0.000 below the α = 0.05 threshold. These results confirm that the independent variables, freight costs (FC) and supply shortages (SS), have a significant influence on the dependent variable, SME profitability. As a result, both hypotheses are supported.

4.4. Moderator Analysis

Table 4 : Moderator results analysis

Y: SMEP X: SS

W: LV S		ample: Size: 385	nple: Size: 385 Model Summary				
R	R-sq	MSE	F	dl1	dl2		р
.656	.603	.372	6.531	3.000	381.0	000	.000
	coeff	se	t	р	LLCI	ULCI	
constant	4.774	.135	72.778	.000	4.462	4.39	8
SS	.632	.176	1.744	.000	.250	.220	
LV	.567	.190	5.208	.000	.282	.252	
Int_1	.590	.182	5.065	.000	.373	.264	

Source: (The authors, 2025)

The p-value for the interaction term (Int_1) is 0.000, which is below the 0.05 threshold, reinforcing that the interaction between SS and LV influences SMEP. The coefficient for Int_1 is 0.590, suggesting that higher levels of LV enhance the effect of SS on SMEP. Consequently, hypothesis H3 is supported, confirming that logistics volatility in the digital age postively influences the profitability of SMEs.

5. DISCUSSION

5.1. Sumary Results

Linear regression showed that freight cost was the most significant contributor to the profitability of small and medium enterprises in selected Asian nations (FC) with a standardized coefficient of -0.72. In addition, supply shortages also contributed to SME profitability in Asia, supporting the financial effect of global supply chain disruptions, with a coefficient of -0.66 (SS). Moreover, logistics volatility acted as a moderator, influencing the connection between supply shortage and SME profitability in selected Asian nations, with a coefficient of 0.59 (LV).

5.2. Theoretical implication

The findings of this study strongly support the thesis that rising freight costs continue to erode SME profitability in selected Asian economies, extending insights from Transaction Cost Economics (Coase, 1937; Williamson, 1985). Despite Industry 4.0 promises, where automation and digital logistics should, at least theoretically, cause transaction costs to decrease, this study uncovers a persistent paradox: freight costs remain volatile, placing huge financial pressures on SMEs (Tang & Musa, 2011). This challenge is particularly acute in economies like Vietnam and the Philippines, where digital infrastructure is expanding, yet SMEs still encounter challenges in cost absorption due to a lack of financial resources. While capitalist theory assumes that market adjustment must inevitably drive efficiency, enabling firms to develop cost-lowering mechanisms (Smith, 1776), this study shows that market forces may not be enough. Where intra-regional trade imbalances and infrastructural fragmentation exacerbate cost differentials (Sharma & Tiwari, 2019), SMEs remain at a disadvantage. In a Marxist perspective, observations also highlight how rising freight costs exacerbate systemic inequalities, where capital-intensive firms are privileged at the cost of SMEs, which are made increasingly vulnerable in the digital era of globalization (Marx, 1867).

The findings of this study confirm that supply shortage poses an acute risk to SME profitability in selected Asian economies, supporting evidence from Transaction Cost Economics (Coase, 1937; Williamson, 1985). In the era of Industry 4.0, with digitalized supply chains and predictive analytics that are expected to build resilience, this research highlights an underlying paradox: despite the technological improvement, the majority of SMEs in emerging economies continue to experience shortages of raw materials, production delays, as well as unstable prices (Christopher, 2016). This paradox is particularly acute in South and Southeast Asia, where, despite growing regional trade integration, SMEs are struggling to organize alternative suppliers (Sharma & Tiwari, 2019). While capitalist theory foretells that supply shortages foster efficiency because they encourage firms to innovate and optimize supply chain networks (Smith, 1776), this study reveals a conflicting phenomenon, larger corporations, with their financial influence, dictate supply chains and SMEs are disproportionately vulnerable to supply chain disruptions (Ngo et al., 2021).

From the Marxist perspective, findings also highlight how supply shortages reinforce economic inequalities, favoring capitalintensive businesses and deepening disparities in more digitalized global economy (Marx, 1867).

Research findings highlight that logistics volatility in the digital era plays a crucial role in shaping the impact of supply shortages on SME profitability in selected Asian economies. Even as Industry 4.0 has been touted as a revolution with the potential to strengthen supply chain resilience through AI-driven forecasting, blockchain tracing, and cloud-supported inventory management systems, this research lays bare a stunning paradox. Despite such advancements, a significant proportion of SMEs in South and Southeast Asia continue to be beset by logistics breakdowns, making them highly vulnerable to supply shortfalls (Christopher & Peck, 2004). Although advocates of digital transformation are convinced that intelligent logistics can allow companies to anticipate and react to disruptions (Lee & Rhee, 2019), this study illustrates a widening gap. Large firms are more capable of investing in high-end digital solutions while the majority of SMEs lack investment capital and technical expertise to apply such solutions effectively (Sharma & Tiwari, 2019). In the Marxist perspective, this digital divide further widens economic inequalities, and logistics volatility still works against SMEs in global trade (Marx, 1867). These findings defy the assumption that digitalization alone can resolve supply chain volatility, stressing the urgency of policy intervention and broader access to technological innovations.

5.3. Practical implications

Despite Industry 4.0 advancements, the impact of freight rates on SME profitability in Asian economies remains controversial (H1). The research supports this with a standardized coefficient of -0.72. The contention is that digitalization, including AI-based logistics and blockchain-enabled freight tracking, has revolutionized cost-effectiveness, which enables SMEs to manage volatile freight markets with greater resilience (Christopher, 2016; Wang *et al.*, 2020). However, critics hold that these technologies have disproportionately benefited large businesses with stronger financial and technological resources, exacerbating the digital divide and leaving SMEs with increasing freight costs (Ngo *et al.*, 2021). In Southeast Asia, RCEP's regional trade facilitation promise is opportunity and threat as declining tariffs may not offset increasing transport costs disproportionately incurred by SMEs (Sharma & Tiwari, 2019). The Marxist school of thought is critical of Industry 4.0's contribution to increasing economic inequalities, contending that digital logistics infrastructure benefits capital-intensive companies at the expense of smaller firms with limited flexibility (Marx, 1867). Policymakers are therefore required to undertake specific interventions to facilitate equal access to digital logistics and reduce the cost imposition on SMEs (Coase, 1937).

The findings confirm that supply shortages negatively impact SME profitability in Asia, reinforcing the notion that global supply chain disruptions impose significant financial burdens. This is supported by a standardized coefficient of -0.66, indicating a substantial effect (**H2**). However, controversy surrounds the degree to which digitalization can reconcile these adversities in Industry 4.0. There are academics who believe that sophisticated technologies, such as predictive analytics and blockchain, enhance supply chain resilience by enhancing transparency and inventory management optimization (Freightos Report, 2021). Empirical evidence shows Indonesian and Malaysian SMEs employing digital tools were able to mitigate supply shocks more effectively, suggesting transformative potential in Asia (Asian Development Bank, 2022). Conversely, critics indicate that digital adoption remains skewed due to economic and infrastructural problems, particularly in South Asia, where Nepalese and Bangladeshi SMEs are hampered by costly implementations and weak regulatory protection (Ngo *et al.*, 2021). The imbalance also fuels ongoing debates on whether digitalization benefits all SMEs or increases prevailing inequalities, necessitating targeted policies that ensure equal access to Industry 4.0 innovation.

The moderating role of logistics volatility in the digital era presents a paradox for Asian SMEs, fueling debates on whether Industry 4.0 technologies alleviate or intensify supply chain disruptions. The research results confirm its statistical impact, with a standardized coefficient of 0.59, moderating the relationship between supply shortages and SME profitability in selected Asian regions (H3). The case that AI-powered forecasting, blockchain-transparency, and cloud-based inventory management allow SMEs to plan ahead for shortages, optimize logistics, and remain profitable although volatile supply chains is advanced (Lee & Rhee, 2019). Malaysia and Vietnam empirical evidence suggest firms leveraging digital logistics platforms reduced operational inefficiencies and rode out supply chain shocks more effectively (Asian Development Bank, 2022). However, critics counter that digital volatility introduces new risks in the shape of cyberattacks, algorithmic failures, and technology unavailability, particularly to South Asian resource-constrained SMEs (Mahapatra & Patra, 2017). Nepalese and Bangladeshi rural enterprises, even today relying on traditional logistics, struggle to adopt these innovations, further exacerbating the digital divide (Zhao, 2021). This contradictory story underlines the need for policy intervention aimed at establishing digital accessibility and cybersecurity resilience so that Industry 4.0 benefits SMEs in different economic situations in Asia.

5.4. Limitation

Notwithstanding that this study provides meaningful information on the impact of global supply chain disruptions on the profitability of SMEs in focus Asian markets, the study has certain limitations. For one, the research is underpinned by a quantitative approach, which though suited to statistical testing may not accurately capture the multifaceted experiences and strategic responses of SMEs in various industries. Second, the study is geographically bounded to specific Asian economies, which can restrict the application of the results to other economies with diverse supply chain structures and economic environments. Third, the application of self-reported survey data to the study has the risk of response bias in that respondents may respond in socially desirable or misleading ways. Lastly, while the study examines the moderating role of logistics volat ility, other external factors such as government policies, trade barriers, and geopolitical risk could also potentially have a material effect on SME profitability but were not directly examined. Further studies should employ a mixed-methods design, expand geographical coverage, and examine moderating variables for a broad spectrum.

5.5. Direction for future research

Future studies should examine the conflicting dynamics of supply chain resilience and digitalization under Industry 4.0 in Asia, as SMEs remain vulnerable amidst technological progress. The strongest argument is on whether digital instruments actually insulate supply chain disruption or instead reinforce the disconnections between big firms and SMEs. Studies need to investigate the extent of digital logistics uptake variability across Asian economies, particularly in rural and urban regions, and its contribution to SME profitability. The ability of government actions to address digital divides and ensure SMEs are resilient to international supply chain shocks should also be examined critically.

5.6. Conclusion

The study finds that the profitability of SMEs in selected Asian regions is significantly impacted by global supply chain disruptions, with supply shortages having the most significant negative effect while freight costs have a significant, though slightly lower, effect. Logistics volatility is a significant moderator, increasing or decreasing these effects depending on SMEs' digitalization and functional flexibility. The research highlights that SME resilience is enhanced by access to digital logistics technology and diversified supply chains. Inequalities in digital access and financial constraints, however, are barriers to widespread adoption. Policymakers must prioritize the development of digital infrastructure and targeted support to improve the resilience of SMEs to global supply chain disruption.

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APPENDIX

Link of the survey: https://docs.google.com/forms/d/1tl9o-7YEhmS13VuBA926ZFbhXbkG1yY8fxdUILo2vI0/previewResponse Table 5: Survey Questionnaire

Variables	ariables Coding Survey content			
Freight Cost	FC1	Freight costs are a central issue for Small and Medium Enterprises (SMEs), with implications for their profitability, pricing, supply chain effectiveness, and competitiveness in the market.	(Choi & Cheng, 2011)	
	FC2	FreightcostsincreasedisproportionatelynegativelyimpactSMEprofitabilityisgroundedin	(Harrison & Chan, 2020; Asian Economic Policy Review, 2021)	

		clear financial strain for SMEs in	
		developing nations.	
		SMEs in these countries have been able to reap the benefits of	
	FC3	technological development in logistics, such as applying more effective route planning and inventory management systems, which help them absorb higher freight costs without affecting profitability disproportionately.	The Asian Development Bank (2022)
	FC4	SMEs in Sri Lanka and Nepal have seen a deterioration in profitability due to increased freight costs.	International Journal of Transport Economics (2021)
	SS1	Supply shortages directly impact SME profitability by increasing raw material prices and leading to delays in production, which ends up undercutting profit margins.	(Nguyen <i>et al.,</i> 2021)
Supply Shortage	SS2	Supply shortages have a highly negative effect on the profitability of SMEs.	(Christopher, 2020)
	SS3	Supply shortages do affect the profitability of SMEs, but the effect is normally manageable.	(International Journal of Transport Economics, 2021)
	SS4	Shortages result in production stoppage and added material costs that are hard for SMEs to bear as they have low finances.	(Christopher, 2020)
	LV1	To Asian SMEs, how efficiently logistics volatility is managed determines if it can ease or exacerbate the negative effects of shortages in supplies.	(Christopher & Peck, 2004)
Logistics Volatility	LV2	Al-based demand forecasting can assist SMEs in anticipating future shortages and preparing for them, reducing stockout risk and operational disruptions.	(Wang <i>et al.,</i> 2020)
	LV3	Cyberattacks, technology glitches, or algorithmic mistakes can result in huge delays or inefficiencies in logistics processes.	(Christopher, 2016)
	LV4	Inadequate digital system integration or insufficient advanced technologies can expose SMEs to disruptions.	(Chen <i>et al.,</i> 2022)
Profitability of Small and Medium Enterprises	SMEP1	Profitability is also one of the decisive factors in the long-term resilience and growth of small and medium-sized	(Beck & Demirgüç-Kunt, 2006)

		enterprises (SMEs) in emerging	
		markets.	
		SMEs that are capable of readjusting	
		operations, diversifying the supply	
s	SMED2	base, and readjusting production	(Chen & Paulrai 2004)
5		plans in response to outside pressures	(Cheff & Faulta), 2004)
		stand a better likelihood of sustaining	
		profitability and building up resilience.	
		With their weak bargaining position,	
C	SMEP3	SMEs are prone to be more exploited	(Tang & Musa 2011)
3		by more powerful supply chain	(Talig & Musa, 2011)
		participants.	
		For highly international supply chain-	
		dependent Asian small and medium-	
C.		sized enterprises, TCE underscores the	(Williamson 1095)
5	SIVIEP4	necessity of exercising control over	(Williamson, 1985)
		key factors of uncertainty, asset	
		specificity, and risk of opportunism.	

ADI	ADDITIONAL QUESTIONS: BACKGROUND INFORMATION								
1	What is your age?	Under 18	18 – 23	24 – 29	Over 30				
2	What is your job title?	Student	Employee	Manager	Others				
3	Which country are you from?	Vietnam	Southeast Asia and South Asia	Others					

Source: (The authors, 2025)

Link of the survey: https://docs.google.com/forms/d/e/1FAIpQLSdBjlB_HYF5UVoVPNsYhMEKXmiEmhZu4Kd-KfZP7deq5EyHow/viewform?usp=header



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