

THE IMPORTANCE OF SUPPLY CHAIN DATA ANALYTICS IN SMES

Annicha Wasurattanapat¹, Poti Chaopaisarn²

1. *Logistics Engineering and Supply Chain Management Program,
Department of Industrial Engineering, Faculty of Engineering,
Chiang Mai University, Chiang Mai, Thailand*

2. *Supply Chain Engineering Management Research Unit,
Faculty of Engineering, Chiang Mai University, Chiang Mai, Thailand*
Corresponding author, Email: poti@eng.cmu.ac.th

ABSTRACT

Purpose: While large corporations leverage data analytics for supply chain optimization, Thai SMEs lag significantly behind despite representing 99% of local businesses. This study investigates how supply chain data analytics (SCDAs) can transform operational performance in resource-constrained SME environments and examines their impact on supply chain decision-making and efficiency.

Design/methodology/approach: The authors has conducted a cross-sectional survey of Thai SME managers across multiple industries using the Technology-Organization-Environment (TOE) framework. Statistical analysis and regression modeling established links between analytics adoption and key performance indicators including inventory turnover, demand forecasting accuracy, and supply chain responsiveness.

Findings: SMEs implementing basic SCDAs achieved improvements in inventory management and demand forecasting accuracy compared to non-adopters. However, only few SMEs currently use supply chain analytics due to perceived complexity and resource constraints. Critical success factors include management commitment, employee training, and phased implementation.

Originality: This study addresses a critical gap by focusing on SME analytics applications in emerging economies. Unlike previous research on large-scale enterprise solutions, the authors demonstrate how simplified approaches deliver substantial value in small-scale operations, providing the first comprehensive analysis of SCDA adoption barriers and success factors specific to Thai SMEs.

Keywords: Supply Chain Data Analytics, Small and Medium-sized, Enterprises, Data Analytics, Operational Performance, Data-driven decision-making

Introduction

The occurrence of natural disasters and the outbreak of Coronavirus disease 2019 (COVID-19) have severely disrupted global supply chain, significantly affecting small business and medium-sized enterprises (SMEs) in Thailand (Babu & Yadav, 2023; Gopal et al., 2024; Khan et al., 2022). Operating in such as a volatile and complex environment, Thai SMEs often struggle with the lack of modern technologies, rigid data systems, and a shortage of skilled professionals (Idemudia, 2023). These limitations hinder their ability to transform large and complex data into actionable insights to support effective decision-making (Waller & Fawcett, 2013).

In this context, Supply Chain Data Analytics (SCDAs) play an important role in linking and integrating data across procurement, inventory, sales, and distribution functions, thereby enhancing demand forecasting, inventory management, and strategic decision-making (Darbanian et al., 2024; Hofmann & Rutschmann, 2018). By facilitating a transition from intuition-driven decisions to evidence strategies, SCDAs enable SMEs to improve operational efficiency and sustain long-term competitiveness (Chatterjee et al., 2022).

This study is aimed to provide empirical evidence of SCDAs' impact on performance metrics, developing a Thailand-specific framework for analytics adoption. The objective is to enhance the

capacity of Thai SMEs to create competitive advantages, respond effectively to rapidly evolving environments, and utilize data-driven insights to support informed and strategic decision-making.

Literature Review

The COVID-19 pandemic exposed the vulnerability of global supply chains and placed particular pressure on SMEs, which account for the majority of enterprises in emerging economies such as Thailand (Babu & Yadav, 2023; Khan et al., 2022). Compared to large corporations, SMEs often face structural disadvantages including financial constraints, limited bargaining power, and resource scarcity that hinder technology adoption (Idemudia, 2023). These constraints not only restrict their operational resilience but also exacerbate their dependency on intuition-based decision-making. As a result, SMEs remain more susceptible to market disruptions, inconsistent forecasting, and inefficiencies in inventory management (Banomyong et al., 2011). At the same time, the strategic importance of data-driven decision-making has grown substantially. Data by itself, however, cannot drive transformation unless firms possess the analytical capabilities to convert it into actionable insights (Ahmed et al., 2020). This is particularly critical for supply chains where the timeliness and accuracy of information directly affect procurement, inventory, and customer responsiveness (Darbanian et al., 2024). SCDA addresses this gap by systematically transforming raw, fragmented datasets into strategic knowledge. Through SCDA, SMEs can enhance demand forecasting accuracy, reduce costs, and strengthen competitiveness by shifting from reactive to predictive decision-making (Hofmann & Rutschmann, 2018; Waller & Fawcett, 2013). A growing body of literature emphasizes the mediating mechanisms through which SCDA enhances operational performance. First, Business Analytics Capabilities (BAC) are central to ensuring that analytical tools are effectively embedded into organizational routines (Gopal et al., 2024). BAC represents the skills, processes, and technologies that enable SMEs to extract value from data. In the absence of BAC, the mere adoption of analytics tools may fail to translate into improved outcomes (Nguyen et al., 2018). Accordingly, H3 and H6 posit that Supply Chain Analysis (SCAs) serves as a foundational enabler of BAC. In turn, BAC functions as critical mechanisms that translate analytical efforts into improved outcomes, thereby positively influencing the overall effectiveness of analytics within SMEs. Second, Collaborative Mechanisms (CM) within the supply chain are identified as another crucial channel. By promoting information sharing and transparency among supply chain partners, CM strengthens trust, reduces conflicts, and supports real-time responsiveness (Chatterjee et al., 2022). The literature shows that analytics-enabled collaboration leads to improved coordination, delivery reliability, and customer satisfaction (Wang et al., 2016). Hence, H1 and H5 are formulated, linking SCAs to CM and CM to operational performance. The adoption of SCDA is further shaped by contextual factors. Third, SCAs reflect leadership commitment, workforce training, and digital infrastructure, serving as a crucial moderating factor in determining how effectively SMEs can convert SCAs into BAC (H2). Similarly, CM influences the extent to which BAC translates into Operational Performance (OP) outcomes (H4). At the same time, the specific dynamics of SCAs influence the differential impact of SCDA on supply chain competitiveness (H3) (Liu & Yang, 2024).

The adoption of SCDA is shaped by contextual factors, best explained through the integration of the Technology-Organization-Environment Framework (TOE Framework) (Baker, 2012; Tornatzky & Fleischer, 1990) and the Resource-Based View (RBV), (Barney, 1991) While the TOE emphasizes organizational conditions and external pressures that facilitate or hinder adoption, RBV highlights the role of unique internal resources in sustaining competitive advantage. Specifically, analytics expertise, digital infrastructure, and managerial capabilities represent valuable, rare, inimitable, non-substitutable (VRIN) resources. These factors critically determine the extent to which SMEs can leverage SCDA to generate strategic outcomes and enhance competitiveness.

In summary, the literature converges on three points: (1) SCDA are no longer optional but essential for SMEs operating in uncertain environments; (2) their value materializes through capability development (BAC) and collaborative relationships (CM); and (3) contextual moderators, as conceptualized by the TOE framework, shape adoption outcomes. These insights directly inform the hypotheses of this study and provide a foundation for analyzing the pathways through which SCDA contribute to SME resilience, efficiency, and long-term competitiveness.

The Conceptual Framework

Goal	Objective	Activity
Enhance OP	To improve forecasting accuracy, strengthen inventory efficiency, and increase responsiveness. Together, these targets aim to reduce uncertainty and enhance overall operational effectiveness.	SMEs can apply predictive analytics to anticipate demand, implement KPI dashboards for real-time monitoring, and pilot digital twin models to simulate production and logistics scenarios. These practices enhance agility and reliability in operations.
Develop BAC	On developing workforce skills in data usage and promoting a shift from intuition-based to data-driven decision-making. This ensures decisions are grounded in evidence rather than subjective judgment.	Training programs strengthen employees' analytical literacy, while open-source tools provide affordable options. Additionally, SME-specific analytics toolkits make adoption practical and scalable.
Foster CM	Objectives emphasize transparent and real-time information sharing to improve visibility, while reducing conflicts and building trust among supply chain partners.	Blockchain supports secure data exchange, IoT and Radio Frequency Identification (RFID), provide real-time tracking, and collaboration platforms enable seamless communication. Collectively, these enhance coordination and trust in supply chains.
Mitigate Resource Constraints	To reduce investment costs in SCDA systems and expand SNEs access to advanced technologies. This helps alleviate financial burdens while broadening digital adoption.	Cloud-based SCM systems reduce upfront costs, analytics hubs provide shared expertise, and government data sandboxes foster innovation. These initiatives ease resource constraints and promote inclusivity.

Table 1: SME Strategic Goals under the TOE framework

The framework identified the critical role of SCAs shaping OP within SMEs, emphasizing their contribution through BAC and CM. Building on the literature review, these factors demonstrate practical significance and provide the basis for hypothesis development. Moreover, Figure 1 presents the specific hypotheses developed from the literature review.

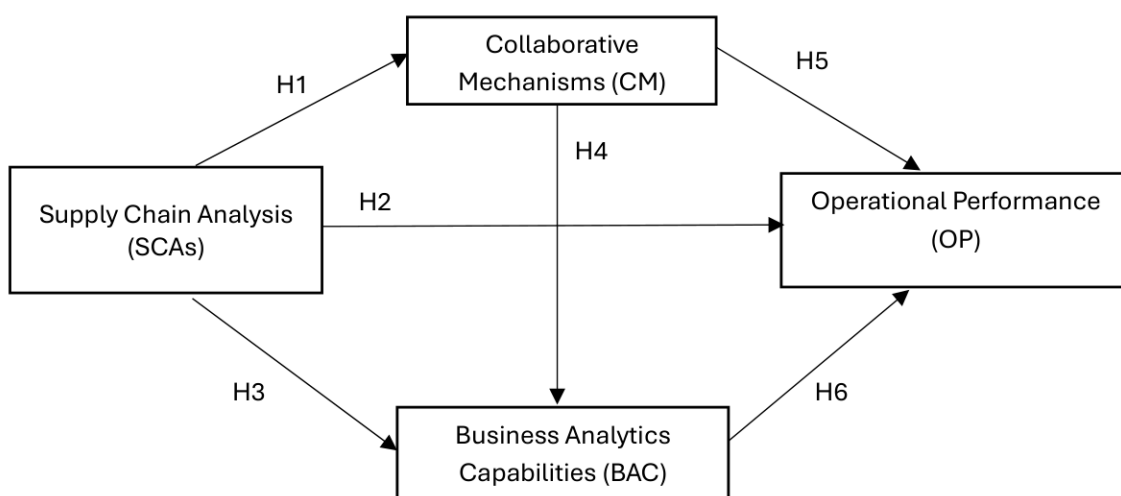


Figure 1: The conceptual Framework of Hypotheses

- H1: The presence of SCAs positively affects the establishment of CM across the supply chain. (Darbanian et al., 2024; Hofmann & Rutschmann, 2018) highlight that supply chain analytics enhance forecasting accuracy, enable real-time information sharing, and increase transparency across partners. Such outcomes promote trust and collaboration, suggesting that SCAs positively influence the establishment of CM.
- H2: The presence of SCAs positively influences OP within the supply chain. (Liu & Yang, 2024) across the supply chain. By integrating data-driven insights into forecasting, inventory management, and coordination, SCAs reduce uncertainty and improve efficiency, thereby strengthening supply chain effectiveness.
- H3: The presence of SCAs positively influences the development of BAC with SMEs. (Ishwarappa & Anuradha, 2015; Nguyen et al., 2018) suggest that the application of big data analytics allows firms to transform raw supply chain data into actionable insights, thereby fostering analytical literacy among employees. This systematic integration facilitates the shift from intuition-based to evidence-driven decision-making. Hence, SCAs are expected to contribute positively to the development of BAC.
- H4: CM positively influences BAC. (Chatterjee et al., 2022; Wang et al., 2016) by fostering trust, promoting information sharing, and strengthening coordination among supply chain partners, CM creates an environment in which data can be more effectively utilized, thereby enhancing the development and application of BAC.
- H5: CM positively influences the OP. Collaboration is widely acknowledged as a critical driver of supply chain performance. (Banomyong et al., 2011) demonstrated its significance in the Thai SME context, while (Khan et al., 2022) show that collaboration mitigates disruption impacts in post-pandemic supply chains. Accordingly, CM is hypothesized to positively influence OP.
- H6: BAC positively influences OP. (Ahmed et al., 2020; Gopal et al., 2024) within the supply chain. Firms that develop stronger BAC can integrate data-driven insights into forecasting, inventory management, and decision-making processes, thereby reducing uncertainty, improving efficiency, and enhancing overall supply chain performance.

Research Methodology

This study adopts a cross-sectional survey design with the of examining the influence of SCAs on the OP of SMEs in Thailand. Such a survey design is particularly appropriate for assessing both the degree of SCAs adoption and empirical impact on organizational performance. The sampling frame was primarily constructed from the Department of Business Development (DBD) database, which serves as a credible, legally validated, and regularly updated source. This ensures that only officially registered and currently active firms are included in the study. To enhance coverage, the DBD database was further supplemented with lists obtained from provincial chambers of commerce and relevant industry associations. To ensure a systematic investigation, and as illustrated in Figure 1, this study specifies and empirically tests the following hypotheses.

Data collection

This study employed a structured questionnaire to collect data from SMEs. Each construction was operationalized through multi-item indicators, typically comprising three to five items, measured on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). To ensure measurement rigor, the instrument underwent pilot testing and expert review, thereby ensuring clarity, validity, and reliability prior to full-scale administration. The instrument was anchored in two complementary theoretical perspectives. The TOE framework (Baker, 2012; Tornatzky & Fleischer, 1990) was applied to capture external determinants of adoption, including technological readiness, organization capacity, and environmental pressures. In parallel, the RBV (Barney, 1991) underscored the strategic importance of firm-specific resources and capabilities that are valuable, rare, inimitable, and organizationally embedded (VRIN) for sustaining competitive advantage. The integration of these perspectives provides a robust theoretical foundation, facilitating an examination of how contextual contingencies

influence adoption decision while internal resources configurations moderate the link between adoption performance outcomes. This dual-lens approach is particularly pertinent to SME, where external pressures are significant, yet long-term competitiveness is contingent upon leveraging distinctive internal resources.

Data Analysis

The analytical procedure was systematically designed to ensure methodological rigor while preserving practical relevance for SMEs. Regression analysis (Chao, 2011) was employed to develop both predictive and explanatory models, thereby improving estimation accuracy and forecasting capability. To enhance the robustness of the empirical framework benchmarking techniques were incorporated, enabling comparative assessment across industry sectors and identifying sector-specific capability gap. The process commenced with pilot administration of the structured questionnaire to 30 SMEs not included in the final sampling frame. This stage served two critical purposes: refining item wording to eliminate semantic ambiguities and conducting preliminary assessments of psychometric properties, including reliability and validity. Items with factor loading (≤ 0.5) or inadequate internal consistency (Cronbach's Alpha ≤ 0.7) were systematically revised or discarded to reinforce construct validity. The validated survey instrument was subsequently administered to the main sample of 200 SMEs, yielding a dataset appropriate for advanced statistical modeling (Banomyong et al., 2011; Liu & Yang, 2024). Data analysis was conducted sequentially using Statistical Package for Social Sciences (SPSS) and Analysis of Moment Structures (AMOS)

Step	Purpose	Method/ Tool	Source
Descriptive Statistics	To present demographic and firm profiles (sector, years in operation).	Frequency distributions and means using SPSS.	(Darbanian et al., 2024; Liu & Yang, 2024)
Reliability and Validity Assessment	To ensure internal consistency and construct validity.	Cronbach's Alpha ≥ 0.70 , Composite Reliability (CR), Average Variance Extracted (AVE), Fornell-Larcker criterion	(Fornell & Larcker, 1981; Gliem & Gliem, 2003)
Confirmatory Factor Analysis (CFA)	To validate the measurement model and confirm one-dimensionality.	Factor loadings, goodness-of-fit indices, and modification indices using AMOS.	(Liu & Yang, 2024)
Structural Equation Modeling (SEM)	To test hypothesized relationships among SCAs, BAC, CM, OP; examine moderating effects across sectors.	Path analysis with AMOS SEM.	(Chao, 2011; Khan et al., 2022)
Benchmarking Outcomes	To position firm-level SCDA adoption relative to industry averages; identify capability gaps.	Comparative assessment framework.	(Banomyong et al., 2011)
Integrated Contribution	To combine statistical robustness with practical implications.	Empirical insights for SME managers and theoretical advancement.	(Babu & Yadav, 2023)

Table 2: Step in Data Analysis

Through this integrated approach, data analysis ensured that findings were both statistically robust and practically meaningful, aligning with the study's objective to evaluate SCDA adoption and its operational impact within Thai SMEs.

Result

The anticipated results of this study highlight the critical role of SCDA in transforming the OP of SMEs in Thailand. The utilization of SCAs should not be narrowly conceived as a cost-reduction mechanism rather, when applied through the expertise of analysts, it functions as a transformational lever that enables SMEs to simultaneously cultivate resilience and strengthen competitiveness within increasingly volatile and complex business environments. First, SCDA are expected to markedly enhance demand forecasting accuracy, thereby allowing SMEs to anticipate fluctuations with greater precision. This advancement transcends the mitigation of overstocking and stockouts, contributing instead to systemic improvements in resource allocation and utilization. By minimizing inefficiencies, SMEs may redirect liberated resources toward innovation and human capital development, thereby reinforcing long-term strategic capabilities. Second, the implementation of SCAs is projected to generate substantial gains in inventory management efficiency by reducing redundancy in stockholding. Importantly, these improvements extend beyond conventional cost optimization to encompass the advancement of sustainability practices, as the reduction of waste from expired or obsolete products introduces an environmental dimension that has been largely absent from the traditional operational agenda of SMEs. Third, SCDA are anticipated to play an instrumental role in reinforcing CM across supply chain networks. By enabling real-time, transparent data exchange, SCDA not only facilitate coordination but also mitigate opportunistic behavior, foster trust, and stabilize long-term inter-firm relationships. These dynamics create conditions conducive to joint investment, collaboration innovation, and the integration of SMEs into broader ecosystems involving larger enterprises. Finally, the presence of SCDA is expected to substantially enhance organizational agility, equipping SMEs with the capacity to respond swiftly and effectively to market turbulence. Such agility not only strengthens responsiveness to evolving customer requirements but also positions SMEs as reliable niche suppliers within global supply chains, wherein multinational corporations increasingly privilege partners who are data-driven, resilient, and strategically adaptive.

In sum, the role of SCDA extends decisively beyond operational optimization to represent a pathway of strategic transformation. Their integration within SMEs is projected to unlock a set of multidimensional advantages, including sustainable inventory practices, enhanced relational trust within supply networks, and expanded opportunities for global integration. Collectively, these outcomes affirm the strategic indispensability of SCDA as a foundation upon which SMEs may build resilience, sustainability, and competitiveness in dynamic and uncertain environments.

Discussion and Conclusion

This study provides empirical evidence that SCDA significantly enhance the OP of Thai SMEs. The results indicate that analytics adoption improves forecasting accuracy, strengthens inventory management, and increases responsiveness. These findings reaffirm the explanatory power of the TOE framework, emphasizing that adoption outcomes are influenced by organizational readiness, technological capability, and environmental conditions. Beyond operational efficiency, SCDA foster the development of BAC and reinforce CM. Together, these enable SMEs to transition from intuition-driven to evidence-based decision-making while simultaneously building trust and transparency with supply chain partners. Nevertheless, adoption remains constrained by financial limitations, shortage of skilled personnel, and perceived technological complexity. These barriers suggest the necessity of incremental and context-sensitive implementation strategies. Looking ahead, the role of SCDA will become increasingly critical as SMEs navigate global market volatility. Adoption will transform supply chains from reactive systems into proactive, predictive, and resilient networks. Rather than being a supplementary tool, SCDA will emerge as a strategic imperative, shaping SMEs capacity to compete internationally, withstand disruptions, and align with digital transformation policies. This evolution highlights SCDA as a central driver of competitiveness, innovation, and long-term sustainability in SME ecosystems.

Conclusion and Suggestions for Future Research

In summary, this study confirms that SCDA adoption, even within resource-constrained environments, yields tangible benefits for SMEs. For practitioners, strong leadership commitment, employee upskill, and enhanced collaboration with partners are key enablers of successful implementation. For

policymakers, the establishment of supportive ecosystems— such as analytics hubs, training programs, and financial incentives— is key to lowering entry barriers.

For future research, several directions are recommended:

- Longitudinal Studies to assess long-term impacts of SCDA on competitiveness and resilience.
- Comparative Research across ASEAN countries to identify regional best practices and contextual differences.
- Framework Development for readiness assessment that SMEs can apply for self-evaluation.
- Field Experiments or pilot projects to translate theoretical models into actionable implementation guidelines.
- Integration Studies examining how SCDA can be combined with AI, machine learning, and digital twin technologies to advance predictive and prescriptive decision-making.

By advancing both practice and research, SCDA will continue to grow in importance, shaping the digital future of SMEs and ensuring their resilience in increasingly volatile global supply chains.

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