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Supply Chain Benchmarking: A Comparative Analysis of Vietnamese and Indian Companies

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Abstract

Purpose: In an age marked by complex global economic interdependencies, the efficiency and robustness of supply chains stand as critical drivers of economic success and sustainability. While both Vietnam and India share the status of emerging economies, they possess distinct characteristics that influence the structure and performance of their supply chains. **Research design, data and methodology:** Thus, the study investigates supply chain performance across selected industries and companies in India and Vietnam, by employing three benchmarks: supply chain length, inefficiency, and working capital productivity. Using MANOVA and subsequent analyses, the differences between industries, countries, and their interaction were examined. **Results:** Results indicate that while all three benchmarks collectively differ significantly, only supply chain inefficiency shows individual variations across industries, countries, and their interaction. Vietnam's smaller geographical size and potentially superior logistics infrastructure likely contribute to its lower supply chain inefficiency. **Conclusions:** The absence of significant differences in supply chain length and working capital productivity suggests convergence in these areas, possibly due to global supply chain integration and standardized practices. As these economies continue to evolve, understanding and adapting to these dynamics will be essential for businesses striving for success in the global marketplace.

Keywords : Supply Chain Performance, Industry Comparison, Supply Chain Inefficiency, Working Capital Productivity, Contextual Factors

JEL Classification Code : O19, L33, R41

1. Introduction

The growth of supply chain management (SCM) in India and Vietnam over the past decade has been driven by rapid industrialization, globalization, and the increasing integration of these economies into global supply chains. In India, the rise of e-commerce, automotive, and pharmaceutical industries have significantly contributed to SCM advancements (KPMG, 2022), while in Vietnam, the electronics, textiles, and footwear sectors have played a pivotal role (PwC, 2023). Both countries have invested heavily in infrastructure, technology, and logistics capabilities to meet the demands of these growing industries. India's supply chain costs as a percentage of GDP have gradually decreased due to improvements in logistics and policy reforms, whereas Vietnam's SCM sector has experienced rapid modernization, particularly in manufacturing and export-driven industries (Deloitte, 2023). This growth is reflected in the declining supply chain costs as a percentage of GDP in both countries over the last five years, indicating increased efficiency and competitiveness in the global market.

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Table 1: Supply Chain Costs as a Percentage of GDP (2019-2023)

Year	2019	2020	2021	2022	2023
India (%)	14.0	13.5	13.0	12.5	12.0
Vietnam (%)	19.0	18.5	17.8	17.2	16.5

The Indian supply chain growth has been driven by E-commerce, Automotive, Pharmaceuticals, Textiles and Apparel, Consumer Electronics and Industrial Machinery (Deloitte, 2023). The supply chain growth in Vietnam is driven by Electronics, Textiles and Apparel, Footwear, Automotive, Food and Beverage and Furniture industries (PWC, 2023). Each of these sectors has a different supply chain requirement and a different improvement measure.

1.1. Rationale for Comparing Vietnamese and Indian Companies

In an era defined by intricate global economic interdependencies, the efficacy and resilience of supply chains emerge as pivotal determinants of economic prosperity (Schierhold, 2012). The growing economies of Vietnam and India, both characterized by rapid growth and progressive integration into global value chains, present a compelling rationale for a comparative analysis of their supply chain landscapes through the lens of benchmarking. Such an analysis would facilitate the identification of best practices in supply chain management across diverse contexts (Dey et al., 2023). By comparing and contrasting the approaches adopted by Vietnam and India, this study can illuminate successful strategies and unveil areas for enhancement in both nations.

While both Vietnam and India share the status of emerging economies, they possess distinct characteristics that influence the structure and performance of their supply chains (Vu & Asher, 2008). A comparative study can elucidate the manner in which factors like infrastructure, regulatory frameworks, and cultural norms shape supply chain operations within each country. Supply chains are susceptible to a spectrum of risks (Nguyen et al., 2021). Thus, a comparative study can aid in assessing the risk resilience of supply chains in Vietnam and India, pinpoint potential vulnerabilities, and propose measures to bolster their capacity to withstand disruptions.

By comprehending the strengths and weaknesses inherent in their supply chains, governments can formulate policies designed to foster efficiency, competitiveness, and sustainability (Dhingra et al., 2022; Truong & Nguyen, 2023). In an era where both countries are actively seeking to deepen their economic ties and participate in regional value chains, a comparative study can catalyze collaboration and knowledge-sharing between Vietnam and India (Truong & Nguyen, 2023). This collaborative spirit can pave the way for the development of joint initiatives aimed at enhancing supply chain performance and generating mutually advantageous opportunities. The insights gleaned from this study can furnish policymakers in both nations with valuable information

1.2. Benchmarking Supply Chain Performance

Benchmarking supply chains is essential for organizations aiming to remain competitive in an increasingly globalized and complex market environment. By comparing their supply chain performance against industry best practices and standards, companies can identify gaps in efficiency, cost-effectiveness, and responsiveness (Gorane & Kant, 2017). Benchmarking allows organizations to assess key performance indicators (KPIs) such as lead times, inventory turnover, and order accuracy, thereby facilitating continuous improvement (Christopher & Holweg, 2017). Furthermore, as supply chains become more integrated and reliant on advanced technologies, benchmarking provides a framework for evaluating the effectiveness of digital transformation initiatives and ensuring that supply chain processes align with strategic business objectives (Gunasekaran et al., 2017).

The dynamic nature of global supply chains, characterized by disruptions such as geopolitical tensions, natural disasters, and pandemics, necessitates a proactive approach to risk mitigation (Wieland & Marcus, 2012). Benchmarking enables organizations to identify vulnerabilities and implement strategies to enhance resilience, such as diversifying supplier bases and adopting more flexible logistics models. Moreover, by understanding how leading companies manage risks, organizations can adopt best practices that strengthen their supply chain's ability to adapt to unforeseen challenges (Ivanov, 2020). Overall, benchmarking serves as a vital tool for maintaining a competitive edge and ensuring the long-term sustainability of supply chains.

Therefore, a comparative study of the supply chains of Vietnam and India, employing benchmarking as a methodological tool, holds immense significance. It possesses the potential to unlock valuable insights, nurture collaboration, and inform policy decisions, thereby contributing to the augmentation of efficiency, resilience, and sustainability within the supply chains of both nations. The subsequent part of the study is structured as follows: The theoretical background was studied in detail and the hypothesis were formulated based on the three key benchmarking measures: Supply Chain Length (SCL), Supply Chain Inefficiency (SCI), and Supply Chain Working Capital Productivity (SWCP). Then the results were tabulated and discussed.

2. Theoretical Background

2.1. Supply Chain Performance Measures - Lag Indicators

Benchmarking supply chains involves assessing performance through various metrics, traditionally including supply chain cost and customer service levels. These metrics are often considered lag indicators, reflecting outcomes rather than leading indicators that might predict future performance (Gunasekaran et al., 2001). Supply chain cost and service levels are inherently trade-off variables, where improvements in one typically come at the expense of the other (Gunasekaran & Kobu, 2007). For instance, increasing service levels, which encompass delivery time, product variety, customer responsiveness, and after-sales service, usually leads to higher costs due to the need for greater inventory, faster shipping, and enhanced customer support (Chopra & Meindl, 2019). Conversely, efforts to reduce costs often result in lower service levels, as streamlined processes and cost-cutting measures may compromise the quality or speed of service provided (Heizer et al., 2017).

Supply chains are generally categorized into two types based on their focus: responsive and efficient. Responsive supply chains prioritize high service levels, emphasizing fast delivery, product customization, and superior customer service (Lee, 2004). These supply chains are designed to be agile and adaptable, often resulting in higher operational costs due to the investments required in inventory management, logistics, and customer support. In contrast, efficient supply chains focus on minimizing costs, often at the expense of service level enhancements. These supply chains aim for operational efficiency through cost-cutting measures such as bulk purchasing, standardized products, and streamlined processes, which can lead to lower service levels but reduced overall costs (Christopher, 2016). Understanding these trade-offs is crucial for organizations aiming to align their supply chain strategies with their business goals and market demands.

2.2. Supply Chain Performance Measures - Lead Indicators

Lead indicators are critical metrics that provide early insights into supply chain performance, focusing on material flow, information flow, and money flow (Bhagwat & Sharma, 2007). These flows are pivotal in influencing lag indicators such as cost and service levels. Effective management of these lead indicators is essential for optimizing supply chain performance and achieving desired outcomes in cost and service quality (Gunasekaran et al., 2001). Material flow, which includes the movement of goods through the supply chain, relies on factors such as transportation efficiency, storage facilities, and infrastructure quality, including roads and rail systems (Christopher, 2016). Efficient management of material flow can significantly reduce costs and enhance service levels by ensuring timely and accurate delivery of products.

Information flow pertains to the exchange of data within and between organizations and is vital for coordinating supply chain activities. It depends on information policies, IT integration, and data completeness, which impact decision-making and operational efficiency (Lee, 2004). Money flow involves financial transactions and depends on factors such as banking networks, IT systems, and government regulations. Efficient money flow ensures smooth financial operations, affecting overall supply chain cost management and financial stability (Heizer et al., 2017). Disruptions in any of these flows can adversely affect supply chain performance, and the resilience of a supply chain is critical for effective recovery from such disruptions (Ivanov, 2020). By focusing on improving these lead indicators, organizations can enhance their lag indicators, optimizing supply chain cost and service levels.

2.3. Problems Faced in Material, Information, and Money Flows in India and Vietnam

The table 2 highlights some of the key issues affecting material, information, and money flows in India and Vietnam, which can impact overall supply chain performance and efficiency.

Table 2: Problems Faced in Material, Information, and Money Flows in India and Vietnam

Flow	India	Vietnam
Material Flow	- Poor infrastructure (roads, railways)	- Underdeveloped logistics infrastructure
	-Inefficient transportation and warehousing	- Limited storage facilities and transportation capacity
	- Bottlenecks in supply chain processes	- Congestion in major ports and transport hubs
Information Flow	- Fragmented IT systems and data silos	- Limited IT integration and information systems
	- Inconsistent data quality and accessibility	- Challenges in maintaining data completeness
	- Regulatory barriers and slow adoption of new technologies	- Lack of standardized information policies
Money Flow	- Complex regulatory environment and bureaucracy	- Inefficient banking systems and financial services
	- Limited integration between financial institutions and supply chain operations	- Slow government transaction processing and lack of digital payment infrastructure
	- High transaction costs and delays	- Challenges in financial transparency and regulation

2.4. Measurable Parameters from Financial Statements

Three key measures can be derived from the balance sheet of a company that are instrumental in benchmarking supply chain performance: supply chain length, supply chain inefficiency, and supply chain working capital productivity (Avittathur & Ghosh, 2020). These measures offer valuable insights into various aspects of supply chain operations, including material flow, cost efficiency, and capital utilization.

2.4.1. Supply Chain Length

Supply chain length is defined as the sum of raw material stocks, work-in-process stocks, and finished goods stocks expressed in terms of days (Shah, 2016). This measure indicates the total inventory held by a firm and reflects the efficiency of material flow within the supply chain. A higher supply chain length suggests slower material flows and extended periods for inventory turnover, which can result in increased holding costs and a larger time gap between material flow and money flow (Christopher, 2016). This metric is crucial for understanding how inventory levels affect overall supply chain performance and cost.

2.4.2. Supply Chain Inefficiency

Supply chain inefficiency is calculated as the ratio of supply chain costs to net sales (Shah, 2016). This measure serves as a lag indicator of supply chain performance, reflecting the proportion of sales revenue that is consumed by supply chain costs. A higher ratio indicates greater inefficiencies and higher operational costs, emphasizing the need for improved cost management and process optimization within the supply chain (Heizer et al., 2017). By benchmarking this ratio, organizations can identify areas where cost reductions are necessary and assess the effectiveness of their supply chain strategies.

2.4.3. Supply Chain Working Capital Productivity

Supply chain working capital productivity measures the efficient use of working capital within the supply chain (Shah, 2016). It reflects how well a firm utilizes its working capital to support material flows and operations. This measure provides insights into the efficiency of capital deployment and its impact on material flow efficiency. Higher productivity indicates better utilization of working capital and more effective management of inventory and receivables, thereby contributing to improved overall supply chain performance (Lee, 2004).

These measures are interrelated as they collectively influence the cost and efficiency of supply chain operations. A firm with high supply chain length may experience increased inefficiencies and reduced working capital productivity due to prolonged inventory holding periods and slower turnover rates. Conversely, optimizing supply chain working capital productivity can reduce supply chain length and inefficiencies by improving inventory management and capital utilization (Christopher, 2016). Understanding and managing these metrics allow organizations to enhance supply chain performance, reduce costs, and improve service levels.

2.5. Different Kinds of Supply Chain Benchmarking Measures

The SCOR (Supply Chain Operations Reference) model and the Balanced Scorecard are two widely recognized frameworks used to benchmark supply chains, each offering unique advantages in measuring and improving supply chain performance. The SCOR model provides a comprehensive approach by standardizing the analysis of supply chain processes across five key areas: Plan, Source, Make, Deliver, and Return. It allows organizations to benchmark their operations against industry standards and best practices, facilitating the identification of performance gaps and opportunities for improvement (Supply Chain Council, 2012). On the other hand, the Balanced Scorecard extends traditional financial metrics by incorporating non-financial performance indicators, such as customer satisfaction, internal processes, and learning and growth. When applied to supply chains, it enables a holistic view of performance, aligning supply chain strategies with broader business objectives and ensuring a balance between short-term and long-term goals (Kaplan & Norton, 1996).

However, implementing the SCOR model and the Balanced Scorecard for supply chain benchmarking is challenging due to several factors. One significant challenge is the lack of accurate and comprehensive data, which is crucial for these models to provide meaningful insights. Many organizations struggle with data collection, integration, and analysis, particularly in complex, global supply chains where data sources are dispersed and often inconsistent (Melnyk et al., 2014). Additionally, both models require standardized improvement principles to be effective, yet many organizations lack the internal expertise or resources to develop and apply these standards consistently. Furthermore, neither the SCOR model nor the Balanced Scorecard adequately captures the three critical supply chain flows: material, money, and information flows. While the SCOR model primarily focuses on process efficiency and the Balanced Scorecard emphasizes strategic alignment, both frameworks often fall short in providing a comprehensive measurement of these flows, particularly in terms of the interdependencies and dynamics between them (Neely, 2005). This limitation can result in a narrow view of

supply chain performance, missing crucial aspects that impact overall effectiveness and resilience.

3. Research Method

3.1. Research Model

The research model for this study is designed to explore and compare the supply chain performance of companies in India and Vietnam using three key benchmarking measures: Supply Chain Length (SCL), Supply Chain Inefficiency (SCI), and Supply Chain Working Capital Productivity (SWCP). The model integrates the relationship between these measures and the overall performance of companies in terms of their financial and operational outcomes.

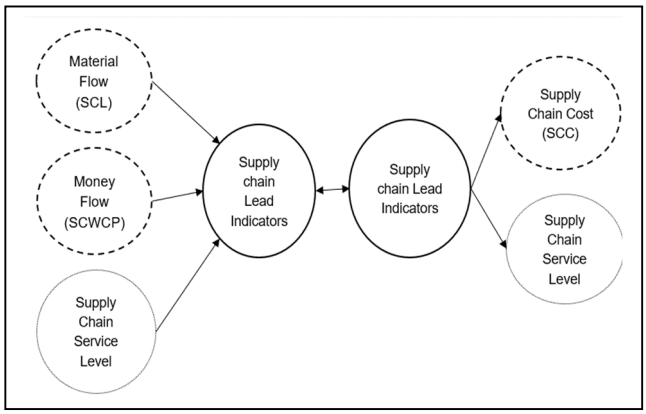

Figure 1: Conceptual Framework

The lead indicators are the enablers for good supply chain working in the comprehensive model for supply chain performance. Material Flow: This is the primary flow that is being analyzed in this study. The supply chain length and the supply chain working capital productivity are measures of material flows. The length measure measures the lead times on both supplier side and customer side. The working capital productivity measures the manufacturing flow efficiency of the company. Information flow: Information flow is excluded from this study as these cannot be recorded by the financial statements of the companies and need other methods to collect, compile and analyze. SCM Performance Lag Indicators: Supply chain costs and supply chain service level. This study does not consider the service level as these numbers are not available in the financial statements of the company. Financial Performance: Measures such as Return on Assets (ROA), Return on Equity (ROE), and Net Profit Margin (NPM). These measures have been neglected in this study as they go beyond the supply chain into the business domain which is influenced by many other factors apart from the supply chain performance alone.

Moderating Variables included for the study includes, the specific industry within which a company operates, influences the supply chain performance of the companies due to specific requirements for each industry. This is an important consideration in this study. Geographical Location: Country-specific factors, including economic conditions, regulatory environment, and market maturity in India and Vietnam. This variable is ignored for this study as the two countries have differing sizes and need data beyond that available from the financial statements. Control Variables includes, Company Size: Measured by market capitalization or total assets, to control for the impact of scale on supply chain performance. Ownership Structure: The influence of ownership, whether state-owned, privately owned, or foreign-owned, on supply chain strategies and performance.

Based on the above discussions, the following hypotheses are proposed for this study

H1: The three supply chain benchmark figures jointly are different for each industry

H2: The three supply chain benchmark figures jointly are different for each country

H3: The three supply chain benchmark figures jointly are different for the country-industry combinations

H4: Supply chain benchmark numbers individually are similar between industries

H5: Supply chain benchmark numbers individually are similar between countries

H6: Supply chain benchmark numbers individually are similar between the industry-country combination

3.2. Data Collection

The selection of the sample was guided by three key criteria to ensure comparability and data integrity across the study's geographic focus on India and Vietnam. First, companies were drawn from industries with a significant presence in both countries to ensure a meaningful basis for comparison. Then, the data availability criterion was applied, restricting inclusion to only those companies with complete financial statements (profit and loss statement, balance sheet, and cash flow statement) for the last five years. Finally, the third criterion reiterated the geographic focus, ensuring representation from both the Indian and Vietnamese companies, concentrating specifically on industries that are vital to the economic structures of each country. Data was collected for a five-year period from 2019 to 2023 for the companies mentioned under table 3 to allow for a robust analysis of trends and performance consistency.

Table 3: Companies from India and Vietnam

Industry	Companies in India	Companies in Vietnam
Pharmaceutical	1. Cipla Ltd 2. Torrent Pharmaceuticals Ltd 3. Aurobindo Pharma Ltd 4. Lupin Ltd 5. Glenmark Pharmaceuticals Ltd 6. Divis Laboratories Ltd 7. Alkem Laboratories Ltd 8. Biocon Ltd	1. Becamex Pharma 2. TRAPHACO 3. Hau Giang Pharmatical 4. OPC Pharma 5. Nam Duoc Joint Stock Company 6. Tirpharco
Food and beverage	1. Hindustan Unilever Ltd 2. ITC Ltd 3. Nestle India Ltd 4. Britannia Industries Ltd 5. Pepsico India Holdings Pvt Ltd 6. Parle Agro Pvt Ltd 7. Dabur India Ltd 8. Godrej Consumer Products Ltd 9. Coca-Cola India Pvt Ltd 10. Vadilal Industries Ltd	1. Vinamilk 2. Habeco 3. Bibica 4. Haihaco 5. Sabeco 6. Cholimex 7. Nam Viet 8. Vinh Hoan
Automotive	1. Maruti Suzuki India Ltd 2. Tata Motors Ltd 3. Hyundai Motor India Limited 4. Mahindra & Mahindra Limited 5. Toyota Kirloskar Motor Private Limited 6. Honda Cars India Limited 7. Renault India Private Limited 8. Hero MotoCorp Limited 9. TVS Motor Company Limited 10. Force Motors Limited	1. Saigon General Service Corporation (Savico) 2. Truong Hai Group Corporation 3. Haxaco (Hang Xanh Motors Service JSC) 4. City Auto Corporation
Electronics	1. Dixon Technologies India Ltd 2. Bharat Electronics Limited (BEL) 3. Bosch Rexroth India Limited 4. Samsung India Electronics Limited 5. Micromax Informatics Limited 6. Voltas Limited 7. Havells India Limited 8. Godrej & Boyce Manufacturing Company Limited 9. Symphony Limited 10. Bajaj Electricals Limited	1. FPT Corporation 2. REE Corporation 3. VINACAP Kim Long Joint Stock (VTE) 4. Viettronics Binh Hoa Joint Stock 5. Post and Telecommunications Construction Material JSC 6. Viettronics Bien Hoa Joint Stock 7. Sametel Corporation (SMT) 8. Post and Telecommunication Equipment Factory JSC 9. Viettronics Tan Binh JSC

3.3. Data Analysis

The three benchmarking measures—supply chain length, supply chain inefficiency, and supply chain working capital productivity—will be computed for each company using the following formulas (Shah, 2009):

Supply Chain Length will be calculated as the sum of days of inventory for raw materials, work in progress, and finished goods. Supply Chain Inefficiency Ratio will be calculated using the formula: SCI=SCC/NS, where SCC represents supply chain costs (distribution costs + inventory carrying costs) and NS represents net sales. Supply Chain Working Capital Productivity will be calculated using the formula: SWCP=NS/SWC, where SWC represents supply chain working capital = (inventory + accounts receivable - accounts payable). The analysis will proceed in the following steps:

Benchmarking within Each Country: Companies will be ranked based on each of the three measures within their respective industries in India and Vietnam. Best and median performing companies will be identified. Cross-Country Comparison: The performance of companies in Vietnam will be compared with those in India, identifying industries where companies in one country outperform those in the other. Cross-Industry Analysis: The study will explore whether companies that perform well on the benchmarking measures in one industry tend to perform similarly across other industries within the same country. This will help in understanding whether there are consistent factors that drive supply chain success across industries.

To ensure the reliability and validity of the findings, the financial data used will be cross-checked with multiple sources to ensure accuracy. The calculated measures will be reviewed for consistency across different years to ensure that trends are not influenced by outliers or one-time events.

4. Results/ Findings and Discussion

The three benchmark indices are calculated and the median, 10th percentile and 90th percentile values are tabulated under table 4. The 10th percentile value represents the best performing companies as regards supply chain length and supply chain inefficiency. The 90th percentile represents best performing companies as regards supply chain working capital productivity. The reason for selecting

10th percentile and 90th percentile is to avoid outliers in the group.

Table 4: Benchmarking Measures

	Industry	Country	SCL (Days)	SCI (Ratio)	SWCP (Ratio)
Median	Automotive	India	287	0.0332	16.3
		Vietnam	48.5	0.02	6.2
	Electronics	India	658	0.0421	6.34
		Vietnam	46.7	0.037	3.09
	Food and Beverages	India	183	0.0638	9.88
		Vietnam	50.3	0.0235	8.23
	Pharmaceutical	India	435	0.0612	4.65
		Vietnam	213	0.0538	4.28
10th percentile	Automotive	India	62.5	0.00996	-15.3
		Vietnam	0	0	0
	Electronics	India	211	0.0174	-3.69
		Vietnam	0	0.00268	0
	Food and Beverages	India	100	0.0235	4.53
		Vietnam	0	0.0159	1.88
	Pharmaceutical	India	218	0.041	3.03
		Vietnam	95.7	0.0283	0.00369
90th percentile	Automotive	India	874	0.0513	70.9
		Vietnam	172	0.063	16.5
	Electronics	India	3254	0.0903	20.9
		Vietnam	179	0.0642	7.73
	Food and Beverages	India	577	0.0976	22.1
		Vietnam	74.8	0.108	20.6
	Pharmaceutical	India	810	0.0845	11.6
		Vietnam	18251	48.9	8.74

The table 4 compares benchmarking measures across industries in India and Vietnam, focusing on three percentiles: Median, 10th percentile, and 90th percentile. Key metrics include Supply Chain Length (SCL), Supply Chain Inefficiency (SCI), and Supply Chain Weighted Cost Performance (SWCP). At the median level, India's Automotive industry shows significantly higher SCL (287) compared to Vietnam (48.5). However, India has a slightly higher SCI (0.0332 vs. 0.02) and a considerably higher SWCP (16.3 vs. 6.2). This indicates that India's automotive supply chain is more extensive but also has higher associated costs and performance. In case of Electronics, India has a substantially higher SCL (658) compared to Vietnam (46.7). India also leads in SCI (0.0421 vs. 0.037), but its SWCP (6.34) is closer to Vietnam (3.09). This suggests India's electronics sector has a larger and moderately costlier supply chain. In the food and beverages sector, India shows higher SCL (183 vs. 50.3) and SCI (0.0638 vs. 0.0235), but Vietnam's SWCP (8.23) remains competitive with India's 9.88. The pharmaceutical sector reflects similar trends, with India outperforming Vietnam across all metrics, including SCL (435 vs. 213) and SCI (0.0612 vs. 0.0538), albeit with a smaller SWCP advantage (4.65 vs. 4.28). In the food and beverages sector, India shows higher SCL (183 vs. 50.3) and SCI (0.0638 vs. 0.0235), but Vietnam's SWCP (8.23) remains competitive with India's 9.88. Its clear highlights that better cost efficiency can be found in Vietnam's supply chain due to the smaller geographic footprint, which reduces transportation and distribution costs. Similar patterns can be seen in the pharmaceutical industry, where India outperforms Vietnam on every parameter, including SCL (435 vs. 213) and SCI (0.0612 vs. 0.0538), although the SWCP advantage is less (4.65 vs. 4.28).

In every category, India performs better than Vietnam at the 10th percentile. For example, Vietnam records zero values, especially in the automobile and electronics industries, whereas India's SCL and SCI are positive even at lower levels. Vietnam's SWCP (1.88) is still reasonably competitive when compared to India's 4.53, but India's SCL (100) and SCI (0.0235) are higher than Vietnam's (0 and 0.0159) in the food and beverage industry. Similar trends may be seen in the pharmaceutical sector, where India achieves higher SCL (218 vs. 95.7) and SCI (0.041 vs. 0.0283), albeit with negligible SWCP differences.

In the majority of industries, India continues to hold a commanding position at the 90th percentile. In the automotive sector, Vietnam's Supply Chain Length (SCL) of 172 is greatly inferior than India's SCL of 874, suggesting a far more intricate and vast supply chain network. This is a result of India's extensive geographic reach, sizable market, and varied business practices, all of which call for a wider network of manufacturers, distributors, and suppliers. However, Vietnam's shorter SCL points to a simpler, more localized supply chain that is easier to maintain, though it may also limit its reach and scalability. Vietnam has a higher Supply Chain Inefficiency (SCI) of 0.063 than India, which has a lower SCI of 0.0513. This discrepancy suggests that India has achieved comparatively superior efficiency and resource optimization despite having a longer supply chain. Better infrastructure, strategic management of its vast network, and technology developments could all be responsible for this. On the other hand, Vietnam's higher SCI indicates a supply chain that is costlier and resource-intensive in comparison to its shorter length, maybe as a result of inefficiencies brought on by inadequate infrastructure or increased operating expenses.

India's SCL (3254) and SCI (0.0903) in electronics are significantly greater than Vietnam's (179 and 0.0642), and the country also achieved a higher SWCP (20.9 vs. 7.73). India's SCL (577) and SCI (0.0976) are higher in the food and beverage sector, but Vietnam's SWCP (22.1 vs. 20.6) is about equal. In the pharmaceutical industry, Vietnam's SCL (18251) and SCI (48.9) are severe outliers, whereas India

leads in SCL (810) and SCI (0.0845). India's SWCP (11.6) is still marginally greater than Vietnam's (8.74), though.

The statistical analysis shows that India and Vietnam have different levels of performance in certain areas, but not overall. Only supply chain inefficiency (SCI) shows statistically significant differences between countries ($F = 18.299$, $p < .001$). Vietnam has lower rates of inefficiency. On the other hand, there are no significant differences between countries in terms of supply chain length and working capital productivity ($p = 0.467$ and $p = 0.690$, respectively). This means that performance is similar in these areas. Table 4's descriptive statistics show that Indian companies have longer supply chains and different ways of doing business. However, these differences are not statistically significant, so they cannot be used to support claims that one country is better than the other. These results show that performance patterns are different for each dimension: Vietnam has a lot less supply chain inefficiency ($p < .001$), but both countries have supply chain length ($p = 0.467$) and working capital productivity ($p = 0.690$) that are statistically similar. This pattern indicates that competitive advantages in emerging markets may be focused on particular operational capabilities rather than indicating overall superiority.

To Test the Hypothesis H1, H2 and H3 formulated for the study, the MANOVA (Multivariate) test was performed and the results were tabulated under Table 5.

Table 5: Multivariate Tests

		Value	F	df1	df2	p
Industry	Pillai's Trace	0.067	4.99	9	1965	< .001*
	Wilks' Lambda	0.933	5.07	9	1589	< .001*
	Hotelling's Trace	0.071	5.14	9	1955	< .001*
	Roy's Largest Root	0.0653	14.26	3	655	< .001*
Country	Pillai's Trace	0.0303	6.79	3	653	< .001*
	Wilks' Lambda	0.97	6.79	3	653	< .001*
	Hotelling's Trace	0.0312	6.79	3	653	< .001*
	Roy's Largest Root	0.0312	6.79	3	653	< .001*
Industry ✻ Country	Pillai's Trace	0.0882	6.61	9	1965	< .001*
	Wilks' Lambda	0.912	6.8	9	1589	< .001*
	Hotelling's Trace	0.0958	6.94	9	1955	< .001*
	Roy's Largest Root	0.0913	19.94	3	655	< .001*

Note: *Significant at 5% significance level

To determine whether there are statistically significant differences between groups, multivariate tests (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root) were used to examine the effects of Industry, Country, and their interaction (Industry ✻ Country). The results of these tests are shown in Table 5. All test statistics report p-values of <.001, indicating that the effects are significant at the 5% significance level. All four test statistics yield identical results for Country: $F(3, 653) = 6.79$, $p < .001$. This convergence happens because there is only one discriminant function when there are only two countries. Country accounts for about 3% of the multivariate variance (Pillai's Trace = 0.0303, Hotelling's Trace = 0.0312), which is a small but important effect. This verifies that India and Vietnam exhibit consistently distinct multivariate profiles across the three supply chain benchmarks. Univariate results indicate significant country differences solely for SCI; thus, this multivariate effect predominantly represents variations in supply chain inefficiency while also encompassing nuanced covariation patterns among all variables. The smaller effect compared to industry shows that the national context is less important than the industry sector in shaping supply chain configurations. Overall analysis reveals that India consistently operates with longer, more complex supply chains across all industries, reflecting its larger geographical scale, diverse market conditions, and fragmented infrastructure. Vietnam has shorter supply chains and lower inefficiency metrics overall, which means it is better at keeping costs down. The reason it is small, has industrial zones close together, and may have better logistics infrastructure in few areas. But India's higher working capital productivity in most sectors shows that Indian companies make more money from their working capital investments, even though they are more complicated. These patterns show that India is more focused on reaching and responding to customers by keeping a lot of inventory, while Vietnam is more focused on running lean and keeping costs low. Neither approach is superior in all circumstances; rather, each is a reaction to distinct national contexts, market frameworks, and competitive forces.

A deeper analysis can test each individual benchmark for differences between industry and country i.e., to test the hypothesis H4, H5and H6. The analysis results were tabulated under the table 6.

Table 6: Univariate Analysis

	Dependent Variable	Sum of Squares	df	Mean Square	F	p
Industry	Total Length	1.17e0+9	3	3.91E+08	1.254	0.289
	SCI	1464	3	488.2	11.755	< .001*
	SWCP	5.96e0+6	3	1.99E+06	1.987	0.115
Country	Total Length	1.65e0+8	1	1.65E+08	0.53	0.467
	SCI	760	1	759.9	18.299	< .001*
	SWCP	159303	1	159303.4	0.159	0.69
Industry ✻ Country	Total Length	1.92e0+9	3	6.39E+08	2.048	0.106
	SCI	2424	3	808.1	19.46	< .001*
	SWCP	434955	3	144985	0.145	0.933
Residuals	Total Length	2.04E+11	655	3.12E+08		
	SCI	27200	655	41.5		
	SWCP	6.55e0+8	655	999477.7		

Note: *Significant at 5% significance level

A detailed univariate analysis of the dependent variables (Total Length, SCI, and SWCP) based on Industry, Country, and their interaction (Industry ✻ Country) is presented in table 6. The univariate analysis shows that the dependent variables, Total Length, SCI, and SWCP, are affected differently by Industry, Country, and their interaction (Industry ✻ Country). A substantial effect on SCI is seen for Industry ($F = 11.755$, $p < .001$), suggesting that SCI is significantly influenced by industry differences. Nevertheless, there are no discernible impacts for SWCP ($p = 0.115$) or Total Length ($p = 0.289$). Likewise, for Country, only SCI ($F = 18.299$, $p < .001$) has a significant influence, whereas Total Length ($p = 0.467$) and SWCP ($p = 0.69$), have no effect.

SCI is also significantly impacted by the interaction term (Industry ✻ nation) ($F = 19.46$, $p < .001$), indicating that the combined effect of industry and nation is crucial for this variable. On the other hand, the interaction has no discernible impact on SWCP ($p = 0.933$) or Total Length ($p = 0.106$). The majority of the variance in the dependent variables is explained by residuals, especially for Total Length and SWCP, highlighting the factors' poor explanatory capacity for those variables. Overall, the findings show that, at the 5% significance level, Total Length and SWCP are not significantly impacted by Industry, Country, and their interaction, but SCI is.

The results clearly indicate that only the supply chain inefficiency is distinctly different between industries, countries and country-industry groups. Both supply chain length and supply chain working capital productivity appear to be similar.

The regression analysis shows that the enabler has a significant impact on the supply chain performance. The material flow in particular is significant, while the money flow does not seem to have a significant impact on the performance of the supply chain. Dependent variable supply chain costs measured by Supply chain inefficiency (SCI). Influencing variables

1. Material flow measured by supply chain length
2. Money flow measured by supply chain working capital productivity (SCWP)
3. Information flow is not considered in this study

Table 7: Regression model fit table

Overall Model Test							
Model	**R**	**R^2**	**Adjusted R^2**	**F**	**df1**	**df2**	**p**
1	0.148	0.0218	0.0189	7.37	2	660	<.001*

Note: *Significant at 5% significance level

With a R value of 0.148 in the table 7, the regression model fit results show a slight positive association between the predictors and the dependent variable. The R2 value of 0.0218 indicates that the model's predictors only account for 2.18% of the variability in the dependent variable, however the Adjusted R2 value of 0.0189 takes the number of predictors into consideration and shows a somewhat lower explanatory power. Overall, the regression model is statistically significant at the 5% level, as shown by the F-statistic of 7.37 with degrees of freedom ($df1 = 2$, $df2 = 660$). Even if the model's explanatory power is poor, the p-value (<.001) supports that at least one predictor has a significant association with the dependent variable as tabulated under Table 8. The model is statistically significant, as this illustrates.

Table 8: Regression Coefficient Table

Predictor	Estimate	SE	t	p
Intercept	0.799	0.268	2.979	0.003*
Total Length	5.78E-05	1.51E-05	3.835	<.001*
SWCP	3.69E-05	2.67E-04	0.138	0.89

Note: *Significant at 5% significance level

The coefficient matrix shows the significant impact of supply chain length on supply chain inefficiency. But the supply chain working capital productivity does now show a significant impact on the supply chain inefficiency. Higher productivity would probably influence the service level. But this measure is now considered in this study. This demonstrates that material flow has a direct connection impact on the supply chain costs while money flow does not show any impact on the supply chain costs. This is probably due to the entire chain operating on those lines.

5. Conclusion

This study sought to compare the supply chain performance of various industries in India and Vietnam, focusing on three key benchmarks: supply chain length, inefficiency, and working capital productivity. The findings from Multivariate analysis of variance (MANOVA) initially indicated significant differences across industries and between the two countries when considering all three benchmarks as a single group. Further examination, however, revealed that only supply chain inefficiency exhibited significant differences across industries, countries, and their interaction. This highlights the pivotal role of cost efficiency, particularly distribution and logistics, in shaping supply chain performance. Vietnam's smaller size and potentially more efficient logistics infrastructure likely contribute to its lower supply chain inefficiency.

The lack of significant differences in supply chain length and working capital productivity, both between industries and countries, suggests a degree of convergence in these aspects. This could be attributed to factors such as global supply chain integration and the adoption of standardized

practices. However, the observed variations in best-in-class performance for each benchmark, as defined by 10th and 90th percentiles, point to industry-specific supply chain strategies and differing national contexts. This aligns with the notion that optimal supply chain configurations depend on industry characteristics and the broader business environment.

The regression model shows a significant impact of the supply chain enablers on the performance of the supply chains. A deeper analysis of the coefficients indicates that material flow has a significant effect on the performance while the money flow does not demonstrate any significant impact on the flow. This gives space for future study on the effect of money flow on supply chain performance and the circumstances under which it would influence the supply chain performance. In conclusion, this study offers insights into the multifaceted nature of supply chain performance in India and Vietnam. It highlights the need for a nuanced approach to supply chain management, one that considers industry-specific requirements, national context, and the interplay of various performance benchmarks. As these two economies continue to evolve, understanding and adapting to these dynamics will be crucial for businesses seeking to thrive in an increasingly competitive global landscape.

Declarations

Ethics Approval and Consent to Participate

Not applicable. This study did not involve human participants or animal subjects.

Competing Interests / Conflicts of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Author Contributions

Dr Priyanga T conceptualized and designed the study, conducted data collection, drafted methodology, performed formal data analysis and wrote the original draft including review and editing.

Dr Vijaykumar N collected data, assisted in data analysis and supported the writing of the original draft including review and editing.

All authors have read and approved the final manuscript.

Data Availability Statement

The data are not publicly available due to privacy or ethical restrictions but can be requested from the corresponding author.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

AI not used

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