International Journal of Economics and Business Management Research
ISSN: 3107-9423 | Volume 2 Issue 2, 100-107, April-June 2026
DOI: https://doi.org/10.64137/31079423/IJEBMR-V2I2P112

Received: 03/04/2026 Revised: 25/04/2026 Accepted: 11/05/2026 Published: 15/05/2026

Original Article

A Study on the Role of Digital Technology in Improving Supply Chain Efficiency Among Retailers in Nagapattinam

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ABSTRACT: *Retail businesses in India's semi-urban districts increasingly face pressure to modernise their logistics and stock-handling practices, yet surprisingly little field-level evidence exists on whether investing in digital tools actually pays off for smaller merchants. This paper set out to investigate that question by surveying 150 retailers spread across grocery, electronics, apparel, and general merchandise shops in Nagapattinam, a coastal district in southern Tamilnadu. Each participant responded to a structured questionnaire built around a five-point Likert scale, covering four constructs: Digital Infrastructure Adoption, Technology-Driven Inventory Management, Data Analytics and Decision Support, and Supply Chain Efficiency. The instrument demonstrated strong reliability, returning an overall Cronbach's Alpha of 0.857. Pearson correlation tests uncovered statistically significant positive links between every independent variable and supply chain efficiency; the tightest association was with Technology-Driven Inventory Management ($r = 0.256$, $p = 0.002$). A multiple regression model incorporating all three predictors proved significant at the one-per-cent level ($F = 6.335$, $p < 0.001$) and accounted for 11.5 per cent of the variance in the outcome measure. Within that model, Technology-Driven Inventory Management ($\beta = 0.192$, $p = 0.019$) and Digital Infrastructure Adoption ($\beta = 0.177$, $p = 0.030$) emerged as individually significant drivers, whereas Data Analytics and Decision Support fell just short of the conventional threshold ($\beta = 0.119$, $p = 0.143$). A chi-square test found no meaningful link between the retailer's age group and the efficiency category achieved ($\chi^2 = 7.539$, $p = 0.480$). Taken together, the results confirm that digital technology adoption does lift supply chain performance in a semi-urban retail setting, though the modest effect size underscores that technology alone is not a silver bullet. The paper closes with practical recommendations—ranging from subsidised connectivity schemes to hands-on digital-skills workshops—that policymakers and trade associations can pursue to accelerate this transformation.*

KEYWORDS: *Digital Technology, Supply Chain Efficiency, Retail Sector, Nagapattinam, Digital Infrastructure Adoption, Technology-Driven Inventory Management, Data Analytics, Decision Support Systems.*

1. INTRODUCTION

Few sectors in India have changed as visibly over the past two decades as retail. What was once a landscape dominated by neighbourhood kirana shops and street-side vendors is now a sprawling, trillion-dollar ecosystem that stretches from air-conditioned hypermarkets in metropolitan cities to modest storefronts in taluk headquarters. Industry observers estimate that the Indian retail market crossed the USD 1,000-billion mark around 2025, powered by a growing middle class, rising household incomes, rapid urbanisation, and perhaps most importantly the explosive reach of mobile internet. E-commerce giants like Amazon, Flipkart, and JioMart have compelled even the smallest shop owners to think about digital payment terminals, cloud-based billing software, and real-time stock tracking. At the heart of every retail operation, whether it handles fresh produce or smartphones, sits the supply chain: the web of activities linking manufacturers, wholesalers, transporters, and point-of-sale counters. When that web runs efficiently, goods arrive on time, shelves stay stocked without wasteful surplus, customers leave satisfied, and margins stay healthy. When it does not, the consequences ripple outward delayed deliveries, spoiled inventory, lost sales, and eroded trust.

Digital technologies a broad umbrella that takes in everything from barcode scanners and cloud-hosted enterprise resource planning software to artificial-intelligence-powered demand forecasting engines promise to tighten that web considerably. Point-of-sale systems capture transaction data the instant a purchase is made; that data feeds into inventory dashboards that flag reorder points automatically; analytics modules crunch historical patterns to predict what will sell next week. In well-resourced metropolitan chains, these tools are already standard. But what about the thousands of retailers scattered across India's semi-urban belts? Nagapattinam, a district on the Coromandel coast of Tamil Nadu known primarily for agriculture, fishing, and pilgrimage tourism, offers a useful vantage point. Its retail landscape mostly small and medium-sized establishments, many family-run—mirrors that of countless other Tier-III and Tier-IV districts. Digital penetration is growing there, thanks partly to government programmes like Digital India and partly to the sheer affordability of smartphones and data plans, yet it remains uneven. This study was conceived to fill a gap in the literature by investigating, with primary field data,

whether and how digital technology adoption improves supply chain efficiency among retailers operating in precisely this kind of setting.

The research draws on several theoretical lenses. The Resource-Based View, articulated by Barney in 1991, holds that firms possessing resources that are valuable, rare, hard to copy, and difficult to substitute can sustain competitive advantages; digital infrastructure increasingly qualifies as such a resource. Transaction Cost Economics, rooted in the work of Williamson (1985), highlights how information-sharing technologies reduce the search, bargaining, and monitoring costs inherent in buyer–supplier relationships. The Technology Acceptance Model proposed by Davis (1989) and its successor, the Unified Theory of Acceptance and Use of Technology developed by Venkatesh and colleagues in 2003, explain why some retailers embrace new tools eagerly while others hold back: perceived usefulness, ease of use, social influence, and the availability of supporting conditions all matter. Finally, the Technology–Organisation–Environment framework of Tornatzky and Fleischer (1990) reminds us that adoption is shaped not just by the technology itself but also by organisational readiness and the external competitive and regulatory environment. Together, these frameworks provide a rich conceptual scaffold for examining digital-technology-driven supply chain improvements in a semi-urban Indian retail context.

1.1. STATEMENT OF THE PROBLEM

Most retailers in Nagapattinam still lean heavily on manual methods to manage their supply chains. Orders are placed over phone calls; stock counts are done by hand, often on paper ledgers; demand forecasts, when they exist at all, rest on gut instinct rather than data. The predictable consequences inaccurate ordering, excess holding costs, delayed fulfilment, and poor coordination with suppliers eat into already thin margins. Meanwhile, evidence from larger urban retailers suggests that even modest investments in digital tools can yield tangible efficiency gains. Yet the extent to which such gains materialise among smaller merchants in semi-urban districts remains an open empirical question, in part because researchers have tended to focus on metropolitan settings and corporate supply chains. Infrastructure gaps, limited digital literacy, financial constraints, and a general wariness of change compound the uncertainty. There is, therefore, a pressing need for field-level evidence on how digital technologies specifically digital infrastructure, technology-driven inventory management, and data-analytics-based decision support relate to supply chain performance in a district like Nagapattinam. This study was designed to generate precisely that evidence.

1.2. OBJECTIVE OF THE STUDY

The primary objective is to investigate the role that digital technology adoption plays in improving supply chain efficiency among retailers operating in Nagapattinam district. The secondary objectives are: to gauge the current level of digital infrastructure adoption among Nagapattinam's retail merchants; to examine how technology-driven inventory management practices relate to supply chain performance; to evaluate whether data analytics and decision support tools contribute to more efficient supply chain operations; to identify the obstacles that retailers in this district encounter when attempting to adopt digital supply chain solutions; and to offer actionable recommendations for accelerating digital transformation in the local retail supply chain.

1.3. NEED OF THE STUDY

This study helps retailers transition from intuition-based stock management to data-informed replenishment, reducing waste and lost sales in the process. It gives policymakers in Tamil Nadu concrete, district-level evidence they can use to design targeted digital-literacy and connectivity programmes. It enables retail trade associations to benchmark members' digital readiness and channel support where it is needed most. It offers transferable lessons for other semi-urban districts across India that share Nagapattinam's demographic and infrastructural profile. Finally, it adds to the still-thin academic record on digital supply chain practices outside metropolitan centres, enriching the broader discourse on inclusive digital transformation.

1.4. SCOPE OF THE STUDY

The study is geographically confined to Nagapattinam district in Tamil Nadu, covering both organised and unorganised retail outlets. It spans four retail segments—Grocery/FMCG, Electronics, Fashion/Apparel, and General Merchandise—ensuring breadth without sacrificing focus. It examines three facets of digital technology (infrastructure adoption, inventory-management technology, and analytics-based decision support) and one outcome construct (supply chain efficiency). Primary data were gathered from 150 retailers via a structured Likert-scale questionnaire; secondary data were drawn from journals, government reports, and industry databases. Results are most directly applicable to small and medium retailers in semi-urban India, though broader directional insights may hold for comparable markets elsewhere.

1.5. LIMITATIONS OF THE STUDY

The sample of 150 retailers, selected through convenience sampling, may not fully represent the district's entire retail population. All data are self-reported; actual operational metrics like inventory turnover or delivery lead times were not independently verified. Because digital technology evolves rapidly, specific findings on tool adoption may date quickly. The cross-sectional design captures a snapshot rather than tracking changes over time. Confidentiality concerns restricted access to

retailers' detailed financial records, limiting the ability to link perceptions to hard financial outcomes. Focusing on a single district means the results may not transfer directly to districts with markedly different infrastructure or demographics.

2. REVIEW OF LITERATURE

Zhen and Shang (2025) – Working with panel data from Chinese A-share listed companies spanning 2019 to 2022, Zhen and Shang explored the pathways through which going digital reshapes supply chain performance. Their empirical analysis revealed that digitalisation boosted efficiency primarily by improving information flow between partners and making operations more transparent.

Rsisinternational Research Group (2025) – This case-based study applied structural equation modelling to Amazon's publicly reported data. The path coefficient between digital transformation and supply chain efficiency came in at 0.664, a convincingly strong figure. The authors contended that Amazon's heavy investment in AI, robotics, and machine-learning algorithms constitutes a hard-to-replicate strategic asset.

Ogunbiyi-Badaru and colleagues (2024) – Adopting the PRISMA framework, the researchers concluded that the greatest potential lies in deploying artificial intelligence, blockchain, and Internet-of-Things sensors in combination rather than isolation.

Holloway (2024) – This systematic review catalogued how blockchain, AI, IoT, and big data analytics are collectively rewriting the rules of supply chain practice. Key patterns included the growing centrality of real-time data visibility and predictive models for demand planning.

Elnadi and Abdallah (2024) – Surveying manufacturing firms, the authors found that simply acquiring digital tools did not guarantee sustainable outcomes. Internal capabilities—absorptive capacity, integration know-how, and a learning orientation—were needed to exploit those tools.

Wu and colleagues (2024) – Wu and collaborators split digital tools into resource-oriented technologies (IoT, big data) and action-oriented technologies (AI, automation). Deploying both in concert yielded resilience benefits greater than either alone.

Fantazy and Tipu (2024) – The authors demonstrated that inventory optimisation acts as a significant mediator between digital tools and broader supply chain performance. Automated tracking cut holding costs and stockouts.

D. Feng (2025) – Combining survey evidence with case studies, the team found that Industry 4.0 tools—IoT, cloud computing, big data, and AI—significantly improved visibility, cut waste, and enhanced resource utilisation.

Karmaker and colleagues (2023) – Focusing on developing-country retailers, this study reported that even basic digital solutions—barcode scanners, cloud-hosted stock ledgers—produced measurable improvements in inventory accuracy and fulfilment speed.

Li and colleagues (2024) – Surveying retail managers in urban and semi-urban settings, the team confirmed that automated replenishment, IoT-enabled stock monitoring, and AI-based demand forecasting collectively reduced holding costs and improved order accuracy.

Bahrami and colleagues (2022) – Through interviews and case studies, the group explored how big data analytics sharpens supply chain decisions, identifying demand-pattern recognition, supplier scoring, route optimisation, and risk flagging as the most impactful applications.

Chatterjee and Chaudhuri (2022) – The researchers found that performance dashboards and analytical reporting tools gave supply chain teams real-time visibility into key indicators, enabling proactive management.

De Vass and colleagues (2021) – Case studies showed that marrying IoT sensor feeds with analytical engines created real-time decision support capabilities that manual monitoring could never match.

Saberi and colleagues (2022) – This mixed-methods study examined how analytics-powered decision support systems bolster transparency in retail supply chains, helping retailers trace product provenance and monitor supplier quality compliance.

Bag and colleagues (2021) – Surveying retail and logistics professionals, the results pointed to improvements in demand forecasting, inventory optimisation, and cost management through cloud computing, AI, and big data platforms.

Qader and colleagues (2022) – Cross-sectoral empirical data showed that firms with higher Industry 4.0 adoption reported superior supply chain performance across cost, delivery reliability, and market responsiveness.

Tian and colleagues (2024) – IoT sensors and AI algorithms open new avenues for supply chain optimisation by revealing patterns that conventional reporting systems miss. Effectiveness hinged on data quality and algorithm sophistication.

Chowdhury and Quaddus (2021) – The researchers built a framework in which digital technology improves supply chain efficiency through enhanced visibility and agility, and those gains in turn support sustainability.

Ali and colleagues (2024) – Hierarchical regression showed that digital transformation bolsters supply chain agility, but the strength of the effect depends on organisational culture.

Zaid and colleagues (2025) – Using PLS-SEM with data from emerging markets including India, the team confirmed that digital transformation lifts multiple facets of supply chain performance.

2.1. RESEARCH GAP

The literature is rich when it comes to large corporations and metropolitan retailers but thins out dramatically for small and medium merchants in semi-urban districts especially in India. Most existing work examines one technology dimension at a time. Very few studies rely on primary survey data from Tier-III or Tier-IV Indian towns. Nagapattinam, with its particular mix of agricultural heritage, coastal geography, and predominantly unorganised retail base, presents a context no prior study has adequately captured. By collecting firsthand data from 150 local retailers and analysing three technology dimensions together, this study addresses these gaps.

3. RESEARCH METHODOLOGY

3.1. RESEARCH DESIGN

A descriptive, cross-sectional survey design was adopted. Data were collected at a single point in time from a sample of 150 retailers, providing a snapshot rather than a longitudinal trajectory. This design permits the identification of associations and the estimation of regression models, though it does not support causal claims in the strict experimental sense.

3.2. TYPE OF DATA

Both primary and secondary data fed into the analysis. Primary data came from retailer responses to a structured questionnaire employing a five-point Likert scale (1 = Strongly Disagree through 5 = Strongly Agree). The questionnaire addressed four constructs: Digital Infrastructure Adoption, Technology-Driven Inventory Management, Data Analytics and Decision Support, and Supply Chain Efficiency, with five items per construct. Secondary data industry reports from IBEF and Deloitte-FICCI, peer-reviewed journal articles, government publications, and company records supplied the contextual and theoretical backdrop.

3.3. SOURCES OF DATA

Primary data were gathered face-to-face from retailers across Nagapattinam's various retail pockets. Respondents came from four business categories: Grocery/FMCG, Electronics, Fashion/Apparel, and General Merchandise. Secondary material was sourced from Google Scholar, JSTOR, government annual reports, and publicly available financial disclosures of major Indian retail firms.

3.4. SAMPLING TECHNIQUE

Convenience sampling, a non-probability method, was used to recruit 150 participants. The target population comprised all retailers in Nagapattinam district, ensuring coverage across the four retail segments noted above.

3.5. DATA COLLECTION METHOD

A structured questionnaire served as the primary instrument. Section A captured demographic details gender, age, education, business type, years in business, annual turnover, and employee count. Sections B through E each contained five Likert-scale statements aligned with the four study constructs. The questionnaire was pilot-tested, refined for clarity, and then administered in full to the 150-respondent sample.

3.6. TOOLS AND TECHNIQUES FOR DATA ANALYSIS

The analytical toolkit included frequency distributions and cross-tabulations for demographic profiling; Cronbach's Alpha for internal-consistency reliability; Pearson correlation coefficients; multiple linear regression; and chi-square test of independence. All statistical processing was carried out in IBM SPSS Statistics, Version 26.

3.7. HYPOTHESES

H1: There is a significant relationship between digital technology adoption variables (DIA, TDIM, DADS) and Supply Chain Efficiency among retailers in Nagapattinam. H2: The three factors collectively predict Supply Chain Efficiency. H3: There is a significant association between age group and the Supply Chain Efficiency category attained by retailers.

4. DATA ANALYSIS AND INTERPRETATION

4.1. PEARSON CORRELATION TEST

Null Hypothesis (H_0): There is no significant correlation between the digital technology adoption variables and Supply Chain Efficiency. Alternative Hypothesis (H_1): There is a significant correlation between the digital technology adoption variables and Supply Chain Efficiency.

TABLE 1 Pearson Correlation Matrix

Variable	DIA	TDIM	DADS	SCE
DIA – Pearson r	1	0.227**	0.195*	0.244**
Sig. (2-tailed)	–	.005	.017	.003
TDIM – Pearson r	0.227**	1	0.196*	0.256**
Sig. (2-tailed)	.005	–	.016	.002
DADS – Pearson r	0.195*	0.196*	1	0.191*
Sig. (2-tailed)	.017	.016	–	.019
SCE – Pearson r	0.244**	0.256**	0.191*	1
Sig. (2-tailed)	.003	.002	.019	–
*N = 150 for all pairs. ** p < 0.01; * p < 0.05*				

(Source: Primary data)

Every pairwise correlation between the three digital-technology constructs and Supply Chain Efficiency turned out positive and statistically significant. The strongest link was with Technology-Driven Inventory Management (r = 0.256, p = 0.002), followed by Digital Infrastructure Adoption (r = 0.244, p = 0.003). Data Analytics and Decision Support also correlated positively (r = 0.191, p = 0.019). The null hypothesis is rejected at the five-per-cent level.

4.2. MULTIPLE REGRESSION ANALYSIS

TABLE 2 Model Summary

Model	R	R Square	Adjusted R^2	Std. Error
1	.339	.115	.097	.56500

Predictors: (Constant), DADS, DIA, TDIM. Dependent Variable: Supply Chain Efficiency.

TABLE 3 ANOVA

Model		Sum of Sq.	df	Mean Sq.	F	Sig.
1	Regression	6.067	3	2.022	6.335	.000
	Residual	46.607	146	.319		
	Total	52.673	149			

TABLE 4 Regression Coefficients

Predictor	B	Std. Err.	Beta	t	Sig.	Tol.	VIF
(Constant)	2.068	.463		4.471	.000		
Digital Infra. Adoption	.179	.082	.177	2.190	.030	.925	1.081
Tech-Driven Inv. Mgmt	.179	.075	.192	2.377	.019	.924	1.082
Data Analytics & DS	.133	.090	.119	1.474	.143	.938	1.066

(Source: Primary data)

The overall model reaches statistical significance (F = 6.335, p < 0.001). The R-squared value of 0.115 tells us the three technology variables account for about 11.5 per cent of the variance in supply chain efficiency. Technology-Driven Inventory Management is the strongest predictor (β = 0.192, p = 0.019), followed by Digital Infrastructure Adoption (β = 0.177, p = 0.030). Data Analytics and Decision Support does not cross the significance threshold (p = 0.143). VIF values remain below 5, indicating no multicollinearity.

4.3. CHI-SQUARE TEST OF INDEPENDENCE

TABLE 5 Age x Supply Chain Efficiency Category Crosstabulation

Age Group	Low	Medium	High	Total
Below 25 years	0 (0.0%)	11 (45.8%)	13 (54.2%)	24

25–35 years	2 (4.2%)	18 (37.5%)	28 (58.3%)	48
36–45 years	0 (0.0%)	14 (32.6%)	29 (67.4%)	43
46–55 years	0 (0.0%)	11 (47.8%)	12 (52.2%)	23
Above 55 years	1 (8.3%)	5 (41.7%)	6 (50.0%)	12
Total	3	59	88	150

TABLE 6 Chi-Square Tests

Test	Value	df	Asymp. Sig.
Pearson Chi-Square	7.539	8	.480
Likelihood Ratio	7.978	8	.436
Linear-by-Linear	.087	1	.768
N of Valid Cases	150		
Note: 6 cells (40.0%) have expected count below 5; minimum expected count is 0.24.			

With a Pearson chi-square of 7.539, eight degrees of freedom, and a p-value of 0.480, there is no basis for rejecting the null hypothesis. The efficiency category a retailer falls into does not depend on the age bracket of the business owner.

5. RESULTS AND DISCUSSION

The retailer sample was nearly gender-balanced (52 per cent male, 48 per cent female), with the largest age group being 25–35 years (32 per cent). Over two-thirds held at least an undergraduate degree, and Grocery/FMCG was the most common business type (31.3 per cent).

A clear majority reported at least moderate agreement with statements about digital point-of-sale systems (51.3 per cent agreed), cloud-based inventory software (46.7 per cent), and digital payment platforms (46.0 per cent), signalling that basic digital infrastructure is taking root.

Among technology-driven inventory management items, automated stock replenishment attracted the highest agreement (48.7 per cent). Data analytics items recorded robust agreement; performance dashboards and analytical pricing tools each topped 56 per cent.

The measurement instrument proved reliable, with individual construct alphas ranging from 0.738 to 0.813 and an overall scale alpha of 0.857.

All three independent variables correlated positively and significantly with Supply Chain Efficiency; Technology-Driven Inventory Management exhibited the strongest association ($r = 0.256$, $p = 0.002$).

The regression model was significant ($F = 6.335$, $p < 0.001$, $R^2 = 0.115$), with Technology-Driven Inventory Management ($p = 0.019$) and Digital Infrastructure Adoption ($p = 0.030$) as individually significant predictors.

No significant association was found between age group and Supply Chain Efficiency category ($\chi^2 = 7.539$, $p = 0.480$).

6. SUGGESTIONS

Retailers should transition from stand-alone billing software to integrated, cloud-hosted platforms that link point-of-sale data directly to inventory records.

District-level trade associations ought to organise hands-on workshops that walk retailers through setting up barcode systems and reading analytics dashboards.

State and central government agencies should channel subsidies toward digital infrastructure in semi-urban retail, including reliable broadband and affordable ERP solutions.

Retailers dealing in perishable goods stand to gain disproportionately from RFID-based tracking and temperature-monitoring sensors.

Financial institutions should design small-ticket digital-adoption loans with streamlined approval processes.

A collaborative digital platform connecting retailers with their regular suppliers could replace phone-based ordering and improve fulfilment timelines.

Regular monitoring and benchmarking exercises would help individual retailers set concrete improvement targets.

7. CONCLUSION

This study set out to investigate whether digital technology adoption makes a tangible difference to supply chain efficiency among retailers in Nagapattinam. Drawing on responses from 150 merchants across four retail segments, the analysis confirms that digital tools particularly those related to inventory management and basic digital infrastructure are positively linked to supply chain efficiency. The regression model, though significant, accounts for just over a tenth of the variance, a reminder that technology is only one piece of a larger puzzle that includes managerial skill, supplier relationships, logistics infrastructure, and market conditions.

The finding that Data Analytics and Decision Support did not achieve individual significance likely reflects that sophisticated analytics adoption is still early-stage in this market. As digital literacy improves and more data accumulate, the payoff from analytics should grow. The absence of any significant link between retailer age and efficiency levels suggests digital benefits are accessible across generational lines. A combination of targeted training, infrastructure subsidies, and peer-learning networks could accelerate the district's digital supply chain journey, offering a replicable model for similar semi-urban regions across India.

7.1. MANAGERIAL IMPLICATIONS

For retail owners, technology-driven inventory management deserves priority attention. Investing in automated reorder systems, barcode or RFID tracking, and demand-forecasting tools is likely to deliver the quickest efficiency returns. Digital infrastructure cloud-based software, reliable connectivity, digital payment integration forms the foundation and should be treated as a non-negotiable investment. Retailers should build internal digital skills through regular training and track supply chain metrics monthly to gauge whether digital investments are paying off.

CONFLICTS OF INTEREST

The author(s) declare(s) that there is no conflict of interest concerning the publishing of this paper.

ACKNOWLEDGEMENTS

The authors wish to thank all the retailers in Nagapattinam district who participated in the survey and generously shared their time and insights.

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