ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VII, July 2026

Strengthening Operational Resilience through Supply Chain Flexibility: Evidence from Textile Industries in Tirupur District

Dr. G. Vignesh[1], Mr. Gowthaman K[2]

[1]Associate Professor, PG & Research Department of Commerce, NGM College

[2]Research Scholar, PG & Research Department of Commerce, NGM College

DOI: https://doi.org/10.51583/IJLTEMAS.2026.150700182

Received: 12 August 2026; Accepted: 17 August 2026; Published: 29 August 2026

ABSTRACT

The textile industry operates in a highly competitive and volatile environment characterized by fluctuating customer demand, raw-material price instability, supplier disruptions, labour shortages, transportation constraints and changing international market conditions. These challenges have increased the importance of operational resilience, particularly the ability of firms to anticipate disruptions, absorb operational shocks, adapt processes, maintain continuity and recover performance. This study examined the influence of supply chain flexibility on the operational resilience of textile industries in Tirupur District, Tamil Nadu. The study specifically examined sourcing flexibility, production flexibility, logistics flexibility and information flexibility as dimensions of supply chain flexibility. A quantitative, descriptive and explanatory cross-sectional research design was adopted. The individual textile firm constituted the unit of analysis, and one knowledgeable owner, manager or senior executive represented each participating firm. Of the 410 textile firms approached, 384 firms provided usable responses, resulting in a response rate of 93.66%. A pilot study involving 30 textile firm owners was conducted individually before the final survey, and the pilot responses were excluded from the final sample. Data were collected using a structured questionnaire and analysed using IBM SPSS Statistics and IBM SPSS AMOS. Reliability and validity were assessed before testing the structural relationships through Structural Equation Modelling. The results indicated that sourcing flexibility ($\beta = 0.214$, $p < 0.001$), production flexibility ($\beta = 0.286$, $p < 0.001$), logistics flexibility ($\beta = 0.241$, $p < 0.001$) and information flexibility ($\beta = 0.318$, $p < 0.001$) had positive and statistically significant effects on operational resilience. The model explained 67.4% of the variance in operational resilience ($R^2 = 0.674$). Information flexibility emerged as the strongest predictor, followed by production flexibility, logistics flexibility and sourcing flexibility. The findings demonstrate that developing flexible sourcing, production, logistics and information capabilities can strengthen the ability of textile firms to withstand and recover from supply-chain disruptions. The study provides empirical evidence from Tirupur's textile cluster and offers implications for managers seeking to build more responsive and resilient supply chains.

Keywords: Operational resilience; Supply chain flexibility; Textile industry; Supply chain disruptions; Supply chain agility.

INTRODUCTION

The textile industry is one of the major contributors to India's manufacturing, employment and export sectors. Tirupur District is internationally recognized as an important centre for knitted garments and textile exports. The district comprises manufacturers, exporters, suppliers, subcontractors, logistics providers and supporting organizations operating through interconnected supply networks. The performance of these firms depends substantially on the timely availability of raw materials, labour, technology, finance, transportation and market information. At the same time, textile firms are exposed to fluctuations in demand, input prices, exchange rates, labour availability and international competition. Such conditions have made effective supply chain management increasingly important for maintaining operational continuity. Textile firms may experience disruptions arising from supplier delays, shortages of yarn and dyes, transportation interruptions, labour

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constraints and changes in customer requirements. International buyers may also impose shorter lead times, consistent quality requirements, competitive prices and reliable delivery schedules. Consequently, firms need capabilities that allow them to respond rapidly to changing operational conditions.

Supply chain flexibility represents an important organizational capability in this context. Flexible firms can modify sourcing arrangements, production volumes, manufacturing processes, delivery schedules and information flows in response to changing circumstances. Sourcing flexibility can enable firms to shift between suppliers when disruptions occur. Production flexibility can allow firms to adjust manufacturing capacity and schedules. Logistics flexibility can facilitate changes in transportation and delivery arrangements, while information flexibility can improve visibility and coordination across supply-chain activities. Operational resilience refers to an organization's capacity to anticipate disruptions, withstand operational shocks, adapt to changing conditions, maintain essential activities and recover performance following disturbances. In the textile sector, operational resilience can be reflected in the ability to maintain production, fulfill customer orders, manage supply shortages and restore normal operations following disruptions.

The relationship between flexibility and resilience has received increasing attention in supply-chain research. However, the characteristics of textile clusters may differ according to their geographical, industrial and market contexts. Tirupur's concentration of textile manufacturers, exporters, suppliers and subcontractors creates a highly interconnected operating environment in which disruption at one stage may influence other stages of the supply network. Although previous studies have examined supply chain resilience and flexibility, relatively limited empirical evidence has specifically examined the contribution of different flexibility dimensions to operational resilience among textile firms in Tirupur District. The present study therefore examined the influence of sourcing flexibility, production flexibility, logistics flexibility and information flexibility on operational resilience among textile firms in the district.

Statement Of The Problem

Textile industries in Tirupur operate in an environment characterized by frequent changes in customer demand, raw-material availability, production requirements, labour conditions, transportation arrangements and international market conditions. Supply-chain disruptions at any stage may interrupt production and affect delivery commitments. Shortages of raw materials, supplier unreliability and transportation delays can result in production interruptions and increased operating costs. Labour constraints may further reduce production capacity. Export-oriented firms may also face additional uncertainty arising from international transportation, trade regulations and changing buyer requirements. Small and medium-sized firms may be particularly vulnerable because of limited financial, technological and managerial resources. Dependence on a restricted number of suppliers or logistics providers can further increase exposure to disruption. When disruptions occur, firms may experience delayed production, order cancellations, increased costs and customer dissatisfaction.

Supply chain flexibility may provide firms with the capability to respond to these challenges. Alternative sourcing arrangements, adaptable production systems, flexible logistics and effective information sharing can enable organizations to respond more quickly to changing conditions. However, the extent to which these individual dimensions contribute to operational resilience among textile firms in Tirupur requires empirical investigation.

Therefore, the present study examined whether sourcing flexibility, production flexibility, logistics flexibility and information flexibility significantly contributed to the operational resilience of textile firms in Tirupur District.

Need Of The Study

The textile industry depends on continuous flows of materials, information, finance and finished products. Disruptions in any of these flows can affect production schedules, delivery commitments, export performance and customer relationships. Understanding the role of supply chain flexibility is therefore important for

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identifying capabilities that can strengthen operational resilience. The study was particularly relevant to Tirupur because the district represents a specialized textile cluster containing manufacturers, exporters, suppliers and subcontractors. The interconnected nature of these firms creates both opportunities for collaboration and potential sources of vulnerability. From a managerial perspective, the findings can assist textile firms in identifying the flexibility dimensions that contribute most strongly to resilience. The study can help managers evaluate alternative sourcing arrangements, adaptable production systems, flexible logistics networks and real-time information-sharing mechanisms.

The study is also academically relevant because it provides empirical evidence connecting supply chain flexibility with operational resilience in a specific textile-industry context. It contributes to the growing literature on supply-chain resilience by examining four specific flexibility dimensions within a major textile cluster. The findings may additionally assist policymakers and industry associations in designing training, digitalization, infrastructure and risk-management initiatives for textile firms.

Scope Of The Study

Geographical Scope: The study was geographically restricted to textile industries operating in Tirupur District, Tamil Nadu. The geographical limitation enabled the study to obtain context-specific evidence from one of India's major textile clusters.

Industrial Scope: The study covered textile manufacturing firms, knitted garment firms, garment export-oriented firms and other textile-related production firms operating in the district.

Conceptual Scope: The study examined supply chain flexibility as the principal explanatory construct. It consisted of: Sourcing Flexibility, Production Flexibility, Logistics Flexibility and Information Flexibility. Operational resilience was treated as the dependent construct and was measured through indicators relating to anticipation, absorption, adaptation, continuity and recovery.

Respondent Scope: One knowledgeable respondent was selected from each participating firm. Respondents included owners/proprietors, general or departmental managers, senior executives and supervisors who possessed adequate knowledge of supply-chain and operational activities.

Analytical Scope: The study used descriptive analysis, reliability analysis and Structural Equation Modelling to examine the proposed relationships between supply chain flexibility and operational resilience.

REVIEW OF LITERATURE

Farrukh and Sajjad (2025), examined supply-chain disruptions and resilience in the textile industry using systemic risk theory and a dynamic capability-based perspective. The study identified pandemics, economic conditions, political developments, natural disasters and geopolitical tensions as major sources of supply-chain disruption. Organizational capabilities, diversification, innovation, digitalization and stakeholder management were identified as important resilience mechanisms. The study highlighted the importance of dynamic capabilities in enabling textile firms to respond to disruption and recover operational performance. These findings provide conceptual support for examining flexibility as an important resilience capability.

Majumdar and Srivastava (2025), examined the role of flexibility in strengthening resilience within textile and clothing supply chains. Their study emphasized that geographically dispersed textile supply chains can be particularly vulnerable to major disruptions. Flexibility was identified as an important capability for maintaining robustness and agility during disruption. The study used the SAP–LAP framework to identify reactive and proactive resilience strategies. The findings provide direct theoretical support for examining the relationship between supply chain flexibility and operational resilience.

Prabavathi and Vanathi (2024), examined supply chain resilience and supply-chain practices among export knitwear industries in Tirupur District. Their study collected primary data from employees working in the export knitwear industry and used SPSS and AMOS for analysis. The research emphasized the importance of

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appropriate supply-chain practices for managing disruptions and improving resilience. The geographical focus of the study makes it particularly relevant to the present research. However, the present study extends this area by examining specific dimensions of supply chain flexibility and their contribution to operational resilience.

Priyanka and Sarnitha Sree (2025), examined operational supply-chain performance among textile exporters in Tiruppur City. Their research focused on operational efficiency, supply-chain challenges and emerging practices. The findings emphasized the relevance of technology-enabled practices for improving operational performance. The study provides contextual evidence regarding the operational challenges faced by textile exporters in Tiruppur and supports the need to examine capabilities that enhance operational continuity.

Paul and Saha (2025), reviewed flexible strategies and performance indicators associated with supply-chain resilience. Their study emphasized that flexibility enables organizations to respond to disruptions by modifying resources, processes and supply-chain arrangements. The review provides theoretical support for examining flexibility as a resilience capability and identifies the importance of evaluating resilience through multiple dimensions.

Research Gap: Previous studies have established the importance of supply-chain resilience and flexibility in managing disruption. However, relatively limited empirical research has examined the individual contribution of sourcing flexibility, production flexibility, logistics flexibility and information flexibility to operational resilience among textile firms in Tirupur District. Existing Tirupur-based studies have examined supply-chain resilience, supply-chain practices and operational performance, but the specific structural relationships between different flexibility dimensions and operational resilience remain comparatively underexplored. The present study therefore addressed this gap by developing and empirically testing a structural model involving four dimensions of supply chain flexibility and operational resilience.

OBJECTIVES AND HYPOTHESES

Objective	Hypothesis
To assess the supply chain flexibility practices and operational resilience of textile industries in Tirupur District.	H_{01}: There is no significant level of supply chain flexibility and operational resilience among textile industries in Tirupur District.
To examine the influence of supply chain flexibility dimensions on operational resilience.	H_{02}: Supply chain flexibility has no significant influence on the operational resilience of textile industries in Tirupur District.
To determine the relative contribution of sourcing flexibility, production flexibility, logistics flexibility and information flexibility to operational resilience.	H_{03}: Sourcing flexibility, production flexibility, logistics flexibility and information flexibility do not significantly contribute to operational resilience.

RESEARCH METHODOLOGY

Research Approach: The study adopted a quantitative research approach. The approach enabled the researchers to measure the study constructs using structured questionnaire items and statistically test the proposed relationships.

Research Design: A descriptive and explanatory cross-sectional research design was adopted. The descriptive component was used to describe the characteristics of the participating firms and respondents, while the explanatory component was used to examine the influence of supply chain flexibility dimensions on operational resilience.

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Study Area: The study was conducted among eligible textile and textile-related manufacturing firms operating in Tirupur District, Tamil Nadu.

Unit of Analysis: The individual textile firm constituted the unit of analysis. One knowledgeable respondent

represented each participating firm. Therefore, the final sample of 384 responses represented 384 separate firms, rather than multiple respondents from the same firms. No firm contributed more than one response to the final dataset.

This ensured that the observations used in the firm-level analysis corresponded to separate organizational units.

Sampling Frame: The sampling frame consisted of identifiable textile manufacturing, knitted garment, garment export-oriented and other textile-related firms operating in Tirupur District. Firms were considered eligible when they were actively engaged in textile production or related supply-chain activities and had an owner, manager or senior executive capable of providing information concerning the firm's sourcing, production, logistics, information and operational practices.

Sampling Method: A purposive sampling approach was adopted to identify eligible firms and knowledgeable respondents. The respondents were selected based on their ability to provide informed information about the firm's supply-chain and operational practices.

The selection of one knowledgeable respondent from each firm ensured consistency between the unit of analysis and the response unit.

Firms Approached and Final Sample: A total of 410 textile firms were approached for participation in the study. One eligible respondent was contacted from each firm, of the 410 firms approached, 384 firms provided complete and usable responses. Thus, the final sample consisted of 384 firms and 384 respondents. The response rate was calculated as: Response Rate=410384×100=93.66%. Therefore, the study achieved a 93.66% response rate.

SUMMARY

Particular	Number
Firms approached	410
Usable responses	384
Non-response/incomplete responses	26
Respondents per firm	1
Final firms represented	384
Final respondents	384
Response rate	93.66%

Pilot Study: Before the final data collection, a pilot study was conducted with 30 textile firm owners individually. The purpose of the pilot study was to evaluate the clarity, relevance and comprehensibility of the questionnaire items and to identify any ambiguity in wording or presentation. The pilot participants were approached individually because they possessed direct knowledge of textile-business operations. Feedback obtained from the pilot exercise was considered while finalizing the questionnaire. Necessary modifications were made to improve the clarity and suitability of the instrument. The 30 pilot responses were not included in the final sample of 384 firms.

Questionnaire: A structured questionnaire was used for primary data collection. The instrument consisted of questions relating to the organizational profile and the major constructs of the study. The supply chain

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flexibility construct consisted of four dimensions: Sourcing Flexibility – 5 items, Production Flexibility – 5 items, Logistics Flexibility – 5 items and Information Flexibility – 5 items. Operational Resilience was measured using 10 items. The substantive items were measured using a five-point Likert scale, ranging from 1 = Strongly Disagree to 5 = Strongly Agree. The questionnaire items were developed with reference to relevant supply-chain flexibility and resilience literature and adapted to the operational context of textile firms in Tirupur District.

Ethical Procedures: Participation in the study was voluntary. The purpose of the research was explained to the respondents before data collection. Respondents were informed that the information provided would be used exclusively for academic research. Confidentiality of responses was maintained, and individual responses were not disclosed in the reporting of the findings. The study reported aggregated results rather than information that could identify individual firms or respondents.

Data Analysis Software: The collected data were coded and analysed using IBM SPSS Statistics and IBM SPSS AMOS. SPSS was used for: Data organization and screening, Frequency and percentage analysis, Descriptive analysis Reliability testing. IBM SPSS AMOS was used for Structural Equation Modelling, including: Measurement model assessment, Factor loading assessment, Composite reliability, Average Variance Extracted, Discriminant validity, Structural path analysis, Coefficient of determination, Effect-size assessment and Predictive relevance assessment

Control Variables: Firm size, years of operation, ownership type, export orientation and number of employees were initially considered as possible organizational characteristics. However, these variables were not incorporated as control variables in the final structural model because corresponding control paths were not estimated in the reported SEM analysis.

Accordingly, these variables were treated only as descriptive organizational characteristics and were not interpreted as statistical controls or predictors of operational resilience.

Proposed study variables

- Independent variable: Supply chain flexibility
- Dimensions: Sourcing flexibility, production flexibility, logistics flexibility and information flexibility
- Dependent variable: Operational resilience
- Resilience dimensions: Anticipation, absorption, adaptation, continuity and recovery
- Control variables: Firm size, years of operation, ownership type, export orientation and number of employees

LIMITATIONS OF THE STUDY

1. Geographical Limitation The study was restricted to textile firms operating in Tirupur District. Consequently, the findings may not be directly generalizable to textile firms operating in other geographical locations.

2. Cross-Sectional Limitation The research used a cross-sectional design and therefore captured supply-chain flexibility and operational resilience during the study period. Longitudinal research could provide greater insight into how resilience capabilities evolve over time.

3. Respondent-Based Measurement: The study relied on responses from one knowledgeable representative of each firm. Although the respondents were selected based on their knowledge of supply-chain operations, organizational capabilities are complex and may be perceived differently by different members of an organization.

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4. Questionnaire-Based Measurement: The constructs were measured through structured questionnaire items. Consequently, some subjective elements may remain in the assessment of supply chain flexibility and operational resilience.

5. Access and Participation: Although 410 firms were approached and 384 usable responses were obtained, 26 firms did not provide usable responses. Non-response may therefore introduce some possibility of response bias.

ANALYSIS OF THE STUDY

Table 1: Sample Distribution of Respondents

S. No.	Type of Textile Firm	No. of Respondents	Percentage
1	Textile Manufacturing Firms	154	40.1
2	Knitted Garment Firms	115	29.9
3	Garment Export-Oriented Firms	77	20.1
4	Other Textile-related Firms	38	9.9
Total		**384**	**100**

Source: Primary Data

Table2: Demographic and Organizational Profile of the Respondents

S. No.	Particulars	Category	Frequency	Percentage
1	**Gender**	Male	242	63
		Female	142	37
		Total	**384**	**100**
2	**Age**	Below 30 years	76	19.8
		30–40 years	128	33.3
		41–50 years	112	29.2
		Above 50 years	68	17.7
		Total	**384**	**100**
3	**Educational Qualification**	Diploma	38	9.9
		Undergraduate	92	24
		Postgraduate	190	49.5
		Professional Qualification	64	16.6
		Total	**384**	**100**
4	**Designation**	Owner/Proprietor	72	18.8
		General/Department Manager	142	37
		Senior Executive	108	28.1
		Supervisor	62	16.1
		Total	**384**	**100**
5	**Years of Experience**	Below 5 years	61	15.9
		5–10 years	118	30.7
		11–15 years	107	27.9

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		Above 15 years	98	25.5
		Total	**384**	**100**
6	**Firm Size**	Small	126	32.8
		Medium	168	43.7
		Large	90	23.5
		Total	**384**	**100**
7	**Years of Operation**	Below 10 years	72	18.8
		10–20 years	124	32.3
		21–30 years	106	27.6
		Above 30 years	82	21.3
		Total	**384**	**100**
8	**Export Orientation**	Domestic Market Only	104	27.1
		Partly Export-Oriented	126	32.8
		Mainly Export-Oriented	154	40.1
		Total	**384**	**100**

Source: Primary Data

Table 3: Reliability Test

S. No.	Constructs	No. of Items	Cronbach's Alpha	Interpretation
1	Sourcing Flexibility	5	0.874	Highly Reliable
2	Production Flexibility	5	0.889	Highly Reliable
3	Logistics Flexibility	5	0.862	Highly Reliable
4	Information Flexibility	5	0.901	Excellent Reliability
5	Operational Resilience	10	0.918	Excellent Reliability
Overall Reliability		**30**	**0.907**	**Excellent Reliability**

Source: Computed Data

Table 4: Cross-Tabulation: Demographic Profile and Research Constructs

Demographic Profile	Category	Reliability constructs				
		S F	PF	LF	IF	OR
Gender	Male	242	242	242	242	242
	Female	142	142	142	142	142
Age	Below 30 years	76	76	76	76	76
	30–40 years	128	128	128	128	128
	41–50 years	112	112	112	112	112
	Above 50 years	68	68	68	68	68
Educational Qualification	Diploma	38	38	38	38	38
	Undergraduate	92	92	92	92	92

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	Postgraduate	190	190	190	190	190
	Professional Qualification	64	64	64	64	64
Designation	Owner/Proprietor	72	72	72	72	72
	General/Department Manager	142	142	142	142	142
	Senior Executive	108	108	108	108	108
	Supervisor	62	62	62	62	62
Years of Experience	Below 5 years	61	61	61	61	61
	5–10 years	118	118	118	118	118
	11–15 years	107	107	107	107	107
	Above 15 years	98	98	98	98	98
Firm Size	Small	126	126	126	126	126
	Medium	168	168	168	168	168
	Large	90	90	90	90	90
Years of Operation	Below 10 years	72	72	72	72	72
	10–20 years	124	124	124	124	124
	21–30 years	106	106	106	106	106
	Above 30 years	82	82	82	82	82
Export Orientation	Domestic Market Only	104	104	104	104	104
	Partly Export-Oriented	126	126	126	126	126
	Mainly Export-Oriented	154	154	154	154	154

Source: Computed Data

SEM ANALYSIS

Table 5.1: Measurement Model – Reliability and Convergent Validity

Construct	Item	Factor Loading	Cronbach's Alpha	Composite Reliability (CR)	AVE
Sourcing Flexibility	SF1	0.782	0.874	0.911	0.672
	SF2	0.841			
	SF3	0.856			
	SF4	0.823			
	SF5	0.806			
Production Flexibility	PF1	0.801	0.889	0.918	0.692
	PF2	0.846			
	PF3	0.875			
	PF4	0.832			
	PF5	0.814			
Logistics Flexibility	LF1	0.785	0.862	0.904	0.653
	LF2	0.824			
	LF3	0.847			
	LF4	0.819			

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	LF5	0.801			
Information Flexibility	IF1	0.821	0.901	0.926	0.716
	IF2	0.867			
	IF3	0.883			
	IF4	0.846			
	IF5	0.851			
Operational Resilience	OR1	0.792	0.918	0.932	0.61
	OR2	0.811			
	OR3	0.825			
	OR4	0.784			
	OR5	0.806			
	OR6	0.817			
	OR7	0.798			
	OR8	0.832			
	OR9	0.801			
	OR10	0.815			

Source: Computed Data

Table 5.2: Discriminant Validity – Fornell–Larcker Criterion

Construct	Sourcing Flexibility	Production Flexibility	Logistics Flexibility	Information Flexibility	Operational Resilience
Sourcing Flexibility	**0.82**	0.621	0.584	0.562	0.638
Production Flexibility	0.621	**0.832**	0.647	0.611	0.681
Logistics Flexibility	0.584	0.647	**0.808**	0.633	0.672
Information Flexibility	0.562	0.611	0.633	**0.846**	0.705
Operational Resilience	0.638	0.681	0.672	0.705	**0.781**

Source: Computed Data

Table 5.3: HTMT Discriminant Validity

Construct	SF	PF	LF	IF	OR
Sourcing Flexibility (SF)	—	0.711	0.682	0.658	0.724
Production Flexibility (PF)		—	0.731	0.706	0.758
Logistics Flexibility (LF)			—	0.719	0.746
Information Flexibility (IF)				—	0.781
Operational Resilience (OR)					—

Source: Computed Data

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Table 5.4: Structural Model – Path Coefficients

Hypothesis	Relationship	Beta (β)	Std. Error	t-value	p-value	Decision
H1	Sourcing Flexibility → Operational Resilience	0.214	0.061	3.508	<0.001	Supported
H2	Production Flexibility → Operational Resilience	0.286	0.064	4.469	<0.001	Supported
H3	Logistics Flexibility → Operational Resilience	0.241	0.059	4.085	<0.001	Supported
H4	Information Flexibility → Operational Resilience	0.318	0.067	4.746	<0.001	Supported

Coefficient of Determination (R^2)

Endogenous Construct	R^2	Adjusted R^2	Interpretation
Operational Resilience	0.674	0.67	Substantial

Source: Computed Data

Table 5.5: Effect Size (f^2)

Relationship	f^2	Effect
Sourcing Flexibility → Operational Resilience	0.071	Small
Production Flexibility → Operational Resilience	0.112	Medium
Logistics Flexibility → Operational Resilience	0.086	Small
Information Flexibility → Operational Resilience	0.146	Medium

Table 5.6: Overall Hypothesis Testing

Hypothesis	Statement	β	t-value	p-value	Result
H1	Sourcing flexibility significantly influences operational resilience.	0.214	3.508	<0.001	**Supported**
H2	Production flexibility significantly influences operational resilience.	0.286	4.469	<0.001	**Supported**
H3	Logistics flexibility significantly influences operational resilience.	0.241	4.085	<0.001	**Supported**
H4	Information flexibility significantly influences operational resilience.	0.318	4.746	<0.001	**Supported**

Source: Computed Data

FINDINGS OF THE STUDY

A. Findings Based on Analysis

1. Profile of Participating Firms and Respondents: The final sample consisted of 384 textile firms represented by 384 individual respondents. Textile manufacturing firms formed the largest category at 40.1%, followed by knitted garment firms at 29.9%. Medium-sized firms represented 43.7% of the sample, while

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mainly export-oriented firms represented 40.1%. The demographic results showed that 63.0% of respondents were male and 37.0% were female. Postgraduates constituted 49.5% of respondents, while general or departmental managers represented 37.0%. These results describe the composition of the participating firms and respondents.

2. Reliability: All study constructs demonstrated satisfactory internal consistency. Cronbach's alpha values ranged from 0.862 to 0.918, while the overall reliability coefficient was 0.907. These results established the reliability of the questionnaire for subsequent analysis.

3. Measurement Model: The measurement model demonstrated satisfactory reliability and convergent validity. Factor loadings exceeded 0.70, Composite Reliability values ranged from 0.904 to 0.932, and AVE values exceeded 0.50. The Fornell–Larcker and HTMT assessments also supported discriminant validity.

4. Structural Model: The SEM results showed statistically significant positive relationships between all four supply chain flexibility dimensions and operational resilience. Information Flexibility recorded the highest standardized path coefficient ($\beta = 0.318$), followed by Production Flexibility ($\beta = 0.286$), Logistics Flexibility ($\beta = 0.241$) and Sourcing Flexibility ($\beta = 0.214$). All relationships were significant at $p < 0.001$.

5. Explanatory Power: The structural model produced an R^2 value of 0.674. Thus, the four supply chain flexibility dimensions collectively explained 67.4% of the variance in operational resilience. The Q^2 value of 0.421 also indicated predictive relevance.

B. Other Findings of the Study

1. Information Flexibility Emerged as the Strongest Predictor: Information Flexibility recorded the strongest standardized path coefficient among the four flexibility dimensions. This suggests that information visibility, timely communication and effective information exchange are particularly important for maintaining resilience. Textile firms depend on information regarding orders, inventory, production schedules, raw-material availability and delivery requirements. Faster access to reliable information can enable firms to identify disruptions and coordinate responses more effectively.

2. Production Flexibility Strengthened Operational Adaptability: Production Flexibility demonstrated the second strongest effect on Operational Resilience. Textile firms frequently need to adjust production quantities, schedules and processes in response to changing orders and material availability. Flexible manufacturing arrangements can help firms reallocate resources and maintain production during unexpected changes.

3. Logistics Flexibility Supported Continuity: Logistics Flexibility had a statistically significant positive relationship with Operational Resilience. Alternative transportation providers, flexible delivery schedules and adaptable logistics arrangements can help textile firms reduce the impact of transportation-related disruptions.

4. Sourcing Flexibility Reduced Supply Vulnerability: Sourcing Flexibility also had a positive and significant effect on Operational Resilience. Alternative suppliers and diversified sourcing arrangements can reduce excessive dependence on individual suppliers and help firms respond to raw-material shortages and supply disruptions.

5. Flexibility Operated as an Integrated Capability: The combined R^2 of 0.674 demonstrates that the four flexibility dimensions collectively provide substantial explanatory power for operational resilience. The findings therefore suggest that resilience is not dependent on one flexibility dimension alone. Rather, firms benefit from an integrated capability involving sourcing, production, logistics and information flexibility.

SUGGESTIONS AND RECOMMENDATIONS

1. Develop Multiple and Flexible Supplier Networks: Textile firms should reduce excessive dependence on individual suppliers by developing alternative and geographically diversified sourcing networks. Backup

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suppliers should be identified for critical yarns, fabrics, dyes, accessories and other production inputs. Supplier evaluation should consider reliability, quality, lead time and disruption-handling capability. Maintaining alternative sources can improve the firm's ability to respond to unexpected supply interruptions.

2. Strengthen Digital Information Integration: Since Information Flexibility recorded the strongest influence on Operational Resilience, firms should strengthen digital integration between procurement, production, inventory, logistics and sales functions. ERP systems, cloud platforms, digital dashboards and real-time information-sharing systems can improve supply-chain visibility. Employees should also receive adequate training in the use of digital systems.

3. Introduce Flexible Production Systems: Textile manufacturers should adopt production systems capable of responding to changes in order volumes, product requirements and raw-material availability. Cross-training employees and maintaining adaptable production schedules can improve resource allocation. Flexible manufacturing capacity can reduce the operational effects of unexpected disruptions.

4. Establish Logistics Contingency Plans: Firms should identify alternative transportation providers, routes and delivery arrangements before disruptions occur. Export-oriented firms should monitor transportation and port-related risks and maintain contingency arrangements for critical shipments. Logistics performance should be monitored using indicators such as delivery reliability, lead time and responsiveness.

5. Develop an Organizational Resilience Culture: Management should establish formal procedures for identifying, assessing and responding to supply-chain risks. Periodic disruption simulations and contingency exercises can improve preparedness. Cross-functional teams involving procurement, production, logistics and finance can coordinate responses during disruptions. Lessons from previous disruptions should be documented and incorporated into future risk-management plans.

CONCLUSION

The study examined the influence of supply chain flexibility on operational resilience among textile industries in Tirupur District. Based on responses from 384 textile firms, the findings demonstrated that sourcing flexibility, production flexibility, logistics flexibility and information flexibility all had statistically significant positive effects on operational resilience. The SEM results showed that information flexibility recorded the strongest influence, followed by production flexibility, logistics flexibility and sourcing flexibility. The structural model explained 67.4% of the variance in operational resilience, demonstrating substantial explanatory power. The findings indicate that textile firms can strengthen their ability to anticipate, absorb, adapt to and recover from disruptions by developing flexible supply-chain capabilities. In particular, information visibility and communication deserve strategic attention because information flexibility demonstrated the strongest contribution in the model.

The study further highlights that operational resilience requires an integrated approach. Supplier diversification alone may not be sufficient if firms lack flexible production, logistics and information systems. Similarly, digital information systems may not produce their full benefit without adaptable operational processes. Textile firms in Tirupur can therefore strengthen resilience by simultaneously developing alternative sourcing arrangements, flexible manufacturing capacity, adaptable logistics networks and integrated information systems.

FUTURE RESEARCH

Future research can extend the present study in several directions:

1. **AI-Powered Supply Chain Resilience:** Predictive analytics and machine learning can be examined as tools for forecasting disruptions in textile supply chains.

2. **Digital Twins and Real-Time Visibility:** Future studies can examine whether digital twins and real-time supply-chain visibility improve resilience and recovery performance.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VII, July 2026

3. **Climate-Smart Textile Supply Chains:** Researchers can investigate how textile firms can build resilience against extreme weather events and environmental disruptions.

4. **Circular Economy and Resilience:** Future research can examine the relationship between circular economy practices, IoT adoption and supply-chain resilience.

5. **Human–AI Collaboration:** Future studies can investigate how collaboration between employees and AI systems influences resilient decision-making in smart textile manufacturing.

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