Examining Recovery Challenges in Bhilwara's Textile Industry Through the DEMATEL Method

Priyanshi Paliwal[1] and Dr. Surbhi Birla[2]

[1] Research Scholar, Department of Management Studies, Sangam University, Bhilwara, Rajasthan.

[2] Associate Professor, Department of Management Studies, Sangam University, Bhilwara, Rajasthan.

Abstract

The textile industry in Bhilwara, Rajasthan—often called the "Textile City of India"—is an essential element of India's manufacturing and export framework, distinguished for its manufacture of polyester-viscose and mixed suiting textiles. Nonetheless, the industry has faced considerable obstacles in post-pandemic recovery, such as supply chain interruptions, financial instability, escalating input prices, and inadequate digital infrastructure. This research utilizes Delphi method to systematically identify and validate the most critical recovery challenges and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique to examine the causal interrelationships among 10 principal recovery obstacles impacting the textile supply chain in the Bhilwara cluster. Expert assessments were gathered using a structured influence-based questionnaire and used to create direct-relation, normalized, and total-influence matrices. The study measures the significance (D + R) and net impact (D − R) of each challenge, categorizing them into cause-and-effect classifications. Findings indicate that supply chain disruptions, financial limitations, decreased capital investment, and rising raw material costs serve as main causal variables, significantly impacting other difficulties. Conversely, variables such as shortages of trained labour, export impediments, and environmental rules are seen as effects, mostly stemming from upstream systemic problems. The D + R vs D − R Cartesian graph facilitates the visualization of relationship structures, allowing policymakers and industry leaders to prioritize initiatives effectively. This paper presents a data-driven framework for strategic planning and emphasizes the need of tackling fundamental obstacles to promote resilient and sustainable recovery in India's textile industry.

Keywords: Bhilwara textile cluster, Delphi method, DEMATEL, supply chain recovery, postCOVID challenges, causal analysis, industrial resilience, policy prioritization.

1. Introduction

The textile and apparel industry in India continues to be a vital pillar of the economy, providing around 2% of the country's gross domestic product, 11 percent of the manufacturing output, and 12–13 percent of the overall revenues from exports (MoT, 2023; IBEF, 2024). Through cotton cultivation, ginning, spinning, dying, logistics, and retail, it is projected that it employs around 45 million people directly and another 60 million workers indirectly (CITI, 2023). There are thousands of power loom units in the Tirupur cluster in Tamil Nadu, and there are historic handloom hubs in Varanasi and Bhagalpur. The ecosystem is extremely diversified, with contemporary composite mills in Bhilwara (Rajasthan), Gujarat, and Maharashtra, as well as thousands of power loom units in many other locations.

1.1 Pandemic-Induced Shocks

The textile sector in India has a significant economic impact, but it has struggled for a long time to overcome structural inefficiencies such as supply chain fragmentation, raw material price volatility, a lack of patient capital, and a slow rate of technology adoption. The COVID 19 lockdowns, which took place between March and May of 2020, resulted in a decrease in capacity utilization in spinning and weaving that was below thirty percent, and export orders totalling three billion dollars were allegedly either cancelled or postponed (CITI, 2023). Migrant workers, who made up about 70 percent of the workforce on the shop floor in certain clusters, went back to their home states, which resulted in a labour shortage just as the units were reopening (Singh et al., 2023). At the same time, the prices of staple Fibers made of cotton and polyester became unstable as a result of bottlenecks in the supply chain and speculative trading (RBI, 2021). Surveys conducted by the industry revealed that working capital cycles ranged from 45 days to more than 120 days, and that there was an increase in the percentage of non-performing assets (NPA) among small and medium-sized enterprises (Mehrotra & Rahman, 2022).

1.2 Government Response and Policy Landscape

To stabilise the sector, the Government of India launched a multi-pronged response:

1. The Emergency Credit Line Guarantee Scheme (ECLGS) disbursed about INR 30,000 crore to textile MSMEs (RBI, 2021).
2. The Production Linked Incentive (PLI) plan allocated INR 10,683 crore for man-made fibers (MMF) and technological textiles, with the objective of stimulating investments of INR 19,000 crore and generating additional exports of INR 70,000 crore by 2028 (DPIIT, 2023).
3. The PM MITRA proposal for mega textile parks envisions the establishment of seven integrated, greenfield parks equipped with plug-and-play infrastructure, aiming for a total of USD 5 billion in foreign direct investment inflows (NITI Aayog, 2022).

However, the implementation and effect of these regulations varies greatly from one subsector to another. For example, handloom cooperatives have a difficult time meeting compliance criterion, whereas technological textile start-ups lament delays in single window approvals. The existence of these differences highlights the need of conducting granular diagnostics at the system level in order to identify leverage areas for action.

1.3 Textile Industry of Bhilwara

The textile industry is a cornerstone of India's industrial landscape, contributing significantly to employment, GDP, and exports. Among the prominent textile hubs in India, Bhilwara, located in the southern region of Rajasthan, has emerged as a major center for synthetic and blended fabric manufacturing. Often referred to as the "Textile City of India", Bhilwara's textile industry has evolved from a modest setup in the early 20th century to a globally recognized manufacturing cluster.

Bhilwara's textile sector primarily specializes in polyester-viscose (PV) and polyester-wool (PW) blended suiting materials, catering to both domestic and international markets. The city is home to more than 900 textile units, comprising spinning mills, weaving facilities, dyeing plants, and processing houses, which together provide direct and indirect employment to over 250,000 individuals. The industrial growth in Bhilwara has been facilitated by supportive infrastructure such as consistent power supply, water availability from the Gandhi Sagar Dam, and robust road and rail connectivity.

Several leading textile companies, including RSWM Ltd. (part of the LNJ Bhilwara Group), Sangam India Ltd., and BSL Ltd., are headquartered in Bhilwara, and their exports contribute significantly to India's textile trade. These firms have played a pivotal role in shaping Bhilwara's industrial identity.

However, the industry is also facing several challenges, including raw material price volatility, labour shortages, environmental compliance issues, and growing international competition. In response, firms are increasingly adopting modernization, automation, and sustainable practices, aided by government initiatives such as the Technology Upgradation Fund Scheme (TUFS) and PM MITRA Parks for Textile Industry.

2. Literature Review

The basic literature on supply chain disruption recovery is examined in this section. The literature on both common and unusual disruptions—like an epidemic or pandemic outbreak—is reviewed.

Ivanov (2020) highlights the susceptibility of global supply networks to systemic disturbances and presents the notion of a viable supply chain, which encompasses agility, resilience, and sustainability. His results are especially pertinent to textiles, as interruptions in global sourcing and logistics networks during the epidemic resulted in gradual breakdowns in procurement and manufacturing.

Choi et al. (2021) examine about how data-driven risk analysis can help with global supply chains. They found that being able to see and respond quickly can help reduce disruptions. This idea is supported by Birtchnell and Urry (2015), who stress the need for digital and distributed manufacturing solutions to make systems less reliant on a few central nodes.

In 2021, Rehman et al. look at the environmental problems that the cloth industry faces. They say that firms are moving toward more environmentally friendly ways of making things because of stricter rules on chemical use, water pollution, and carbon emissions. But putting these into action requires a lot of money up front and changes to how things work, which needs financial support and clear policies.

Sabaghi and Mascle (2016) used unclear reasoning to look at how sustainable cloth supply lines are. They discovered that it's hard for small and medium-sized businesses to find a balance between making money and being good to the environment. Their research finds interconnected problems like getting access to cash and having the right technology ready.

Migration and job instability brought on by the epidemic made labour shortages and skill mismatches worse. According to a study by Mahajan and Tomar (2021) on the effects of COVID-19 on SMEs, labour concerns were one of the main barriers to recovery, particularly in labour-intensive industries like textiles. Many textile clusters still lack adequate digital infrastructure. According to Kamble et al. (2020), Industry 4.0 technologies have the potential to promote sustainability and lean production. However, significant obstacles to digital transformation include a lack of IT infrastructure, technical expertise, and internet connectivity. Using sentiment analysis of management communications, Sharma et al. (2020) shown that throughout the COVID-19 pandemic, there was a generalized worry about capital availability and investment deferral. Their results are consistent with those of Kumar and Bansal (2020), who noted that SMEs' capacity to engage in modernization was impacted by severe credit constraints.

Problems with exports are another persistent issue. Paul and Chowdhury (2020) show that changing international trade rules and problems with logistics made it harder for textile companies to sell their goods. They stress that getting back on track needs a big-picture view of how trade and industrial capacity are aligned.

Fontela and Gabus (1976) were the first to use DEMATEL to map out causal connections and study complex problem structures. Researchers like Thakkar et al. (2007) and Lin and Wu (2008) have used it to study business processes and supply chains since then. Because DEMATEL can tell the difference between cause and effect, it can be used for textile industry recovery research.

In 2016, Bouzon et al. used fuzzy DEMATEL to look at hurdles in reverse logistics, and in 2011, Dey et al. looked at logistics sustainability. Both studies show that DEMATEL is good at making decisions based on more than one factor, especially when systemic feedback loops and user opinions are important. In addition to DEMATEL, Basole and Bellamy (2014) say that network mapping tools can help find key risk transmission paths and resilience nodes. These tools are very helpful in the textile industry, where interdependencies and different levels of supplier relationships make disruptions worse.

The present study examines the structural challenges and resilience of Bhilwara's textile industry, particularly in the wake of recent disruptions such as the COVID-19 pandemic, using advanced analytical methods like DEMATEL to identify cause-effect relationships among key industry factors.

3. Objective of the study

This research seeks to comprehensively examine the interconnected recovery obstacles encountered by the textile sector in Bhilwara, Rajasthan, after recent disruptions, including the COVID-19 epidemic. This research utilizes the Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique to identify, characterize, and categorize primary barriers according to their causal interdependencies.

The explicit aims are as follows:

4. To ascertain 10 pivotal recovery obstacles pertinent to the Bhilwara textile cluster via expert consultation and literature synthesis.
5. To measure the extent of reciprocal impact among these difficulties by expert evaluations.
6. To implement the DEMATEL approach for quantifying the direct and indirect links among issues.
7. To differentiate between causal (driving) and effect (resulting) difficulties using prominence and relation indicators.
8. To provide strategic guidance to governments and business leaders by delineating the underlying interconnections among the concerns.

This research enhances the academic discussion on industrial recovery, specifically on supply chain resilience and regional textile systems, by providing an empirically based, systemsoriented diagnostic methodology.

4 Material and Methods

4.1 Study Area and Industrial Context

One of the greatest concentrations of synthetic fabric in India may be found in the Bhilwara District, which is situated in the south-eastern part of Rajasthan. There are over 900 registered units that are located in three adjacent estates known as Mandpam, Pur Road, and RIICO. These units include spinning, weaving, dyeing, and processing factories that jointly generate more than 100 million meters of suiting fabric every single month (DIC, 2024). The connection provided by National Highway 79 and wide gauge rail is advantageous to the cluster since it guarantees a consistent flow of fiber and completed items into and out of the area.

4.2 Identification of Recovery Challenges

A three-stage procedure was used to derive the ten recovery challenges (C1–C10):

1. Literature review: 52 peer-reviewed articles from 2015 to 2024 and 8 government or multilateral reports were coded, which led to 22 preliminary issues.
2. Focus group workshop: Eight top plant managers and supply chain heads ranked these problems by how often they happened and how important they thought they were, which cut the list down to 14.
3. Delphi rounds: After two email-based rounds with 11 experts (five academics and six business people), everyone agreed on the last ten tasks (Kendall's W = 0.78).

4.3. Delphi Method for Expert Consensus

This study employs the Delphi method to systematically identify and validate the most critical recovery challenges in Bhilwara's textile supply chain. This structured, iterative process is designed to elicit expert consensus on complex issues (Linstone & Turoff, 2002). This approach proves to be especially useful in situations where there is a scarcity of direct empirical data, necessitating the reliance on expert judgment to analyze systemic interdependencies (Okoli & Pawlowski, 2004). Fifteen experts were participated in the process, including seven heads of production or supply chains who had a minimum of ten years of experience in textile manufacturing, logistics, or government industrial promotion, four executives from RIICO, and four faculty members from MLV Government Textile & Engineering College. Two rounds of the Delphi method were executed from the 15th of April to the 30th of September 2022. There were nine in-person interviews and six email correspondences conducted within this period of time spanning. A response rate of 87% was obtained.

4.4 Delphi Procedure

Round 1 is a blend of qualitative and quantitative inquiries, aimed at obtaining comprehensive insights and preliminary assessments of impact.

• Open-ended questions solicited respondents to articulate the most critical supply chain recovery challenges and their organizational implications.

Pairwise impact evaluations were performed on a 0–4 Likert scale to quantify the degree of effect one challenge had on another (0 = No influence, 4 = Very strong influence).

Round 2 presented participants with anonymised statistical summaries (e.g., median scores, interquartile ranges) from Round 1, alongside their individual comments, allowing them to reevaluate their contributions based on group feedback. This iteration facilitated consensus, reduced bias from influential persons, and improved the dependability of the outcomes.

4.5 *The* **Delphi questionnaire** *covered three sections:*

Section A: General Perceptions

1. What are the top three recovery challenges your organization faced post-COVID-19?
2. How has supply chain disruption affected production or order fulfilment?
3. What financial constraints (e.g., liquidity, working capital) created bottlenecks during recovery?
4. How significant has the decline in capital investment been in your unit or region?
5. Have government policies been predictable and helpful for textile sector recovery?

Section B: Pairwise Influence Ratings

Experts rated how much one challenge influences another:
1. To what extent does *financial constraint (C3)* affect *capital investment decline (C10)*? 2. Does *raw material cost increase (C6)* drive *supply chain disruption (C1)*? 3. How strongly does *policy uncertainty (C4)* influence *export barriers (C7)*? 4. To what extent does *lack of skilled labour (C2)* contribute to *demand volatility (C5)*?
5. Does the *digital infrastructure gap (C8)* aggravate *supply chain disruption (C1)*?

Section C: Additional Insights

1. Are there any additional challenges not listed that merit inclusion? 2. What policy interventions do you consider most effective for long-term supply chain resilience?

4.6 Consensus Validation

The experts in the second round were highly in agreement, as shown by Kendall's coefficient of concordance ($W = 0.78$, $p < 0.01$), which supported using the aggregated direct-relation matrix as a strong basis for the DEMATEL study.
In order to set the stage for the next DEMATEL calculation, the Delphi procedure allowed for an empirically based, context-sensitive identification of the top 10 recovery difficulties and the relationships between them.

4.7 Data Processing and DEMATEL Computation

The direct connection matrix Z was made by taking the average of each individual matrix. The maximum row sum (26) was used to make Z normal, which gave us matrix X. Next, the total relation matrix T was found by using MATLAB R2024a to find $T = X (I - X)^{-1}$. This was then checked in Excel 365. Prominence (D + R) and Relation (D - R) scores were given by the row sums (D) and column sums (R) of T each. Cause and effect groups could be seen on a scatter plot of D + R versus D − R.

4.8 Research Design

A quantitative, expert-based DEMATEL (Decision Making Trial and Evaluation Laboratory) methodology was used to analyze the interconnections among 10 identified recovery obstacles in Bhilwara’s textile industry. The difficulties were identified via a multi-phase approach that included a literature review, expert Delphi rounds, and stakeholder input, guaranteeing contextual relevance and empirical foundation.

Table 1. The 10 principal challenges for the study

Code	Challenge	Description
C1	**Supply Disruption**	Interruptions in sourcing, logistics, and vendor coordination.
C2	**Lack of Skilled l**	Shortage of trained workforce due to migration, illness, or skill gaps.
C3	**Financial Constr**	Difficulty in accessing working capital, loans, or delayed payments.
C4	**Policy Uncertain**	Unpredictable or rapidly changing government regulations or trade policies.
C5	**Demand Volatili**	Fluctuating market demand, especially in international and urban markets.
C6	**Raw Material Increase**	Rising prices and availability issues of cotton, dyes, yarn, etc.
C7	**Export Barriers**	Tariffs, customs delays, or bans affecting global shipments.
C8	**Digital Infrastru Gap**	Poor adoption of digital tools (e.g., ERP, supply chain visibility platforms).
C9	**Environmental Regulations**	Stricter environmental compliance affecting operations and cost structures.
C10	**Capital Inv Decline**	Reduced investment in automation, plant upgrades, or R&D post-crisis.

4.9 The DEMATEL Analysis Procedure

The DEMATEL analysis is conducted using the following sequential steps to quantify and interpret the interdependencies among the identified challenges:

1. **Construct the Direct-Relation Matrix (Z)**

Each expert will provide influence judgments between every pair of factors, forming an individual 10×10 matrix. These matrices will then be aggregated by arithmetic mean to generate a group consensus matrix (Z), reflecting the average perceived influence among the factors.

2. **Normalize the Matrix (X)**

The direct-relation matrix Z is normalized to ensure all values fall within a comparable range. This is achieved by dividing each element in Z by the maximum row sum across all rows. The resulting matrix X represents the scaled direct influence between factors.

3. **Compute the Total Influence Matrix (T)**

The total-relation matrix T is computed using the formula:
\[T = X (I - X)^{-1} \] where I is the identity matrix. This step captures both direct and indirect influences of one factor on another throughout the entire system.

4. **Calculate Influence Metrics (D and R)**

Two key metrics are derived from the total-relation matrix T:

- **D (Dispatching Influence):** The row sum of T for each factor, representing the total influence a factor exerts on others.
- **R (Receiving Influence):** The column sum of T for each factor, indicating the total influence a factor receives from the rest of the system.

5. **Prominence and Relation Analysis**

For each factor:

- **Prominence (D + R)** is calculated to determine how significantly a factor is involved in the network, whether as an influencer or as one being influenced.
- **Relation (D − R)** is calculated to classify the factor as either:
  - ✦ a **cause** (D > R), indicating it influences other challenges more than it is influenced, or
  - ✦ an **effect** (D < R), suggesting it is more of a consequence of other challenges.

6. The outcomes will be shown in a D + R vs D − R Cartesian graph, clearly differentiating the drivers (causal group) from the dependent variables (effect group), hence aiding in strategic policy development.

5. <u>Results</u>

To determine the values in the DEMATEL, namely D (Dispatching), R (Receiving), D+R (Prominence), and D−R (Relation) for each challenge, the first step included experts assessing the impact of each element on others using a scale from 0 (no influence) to 4 (very strong influence). Each expert constructed a 10×10 matrix for 10 jobs, with the diagonal elements, indicating self-influence, set to zero (**Table 2**). Subsequently, the various matrices were averaged element-wise to get the group direct-relation matrix Z (**Table 3)**.

Table 2. The Direct-Relation Matrix (Z) is built using expert evaluations, with each element Zij indicating the extent to which factor i affects component j.

	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
C1	0	2	3	2	2	3	1	2	1	2
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
C2	2	0	2	1	2	2	2	2	1	2
C3	3	2	0	2	3	2	1	2	1	3
C4	2	1	2	0	2	2	1	2	2	2
C5	2	2	3	2	0	2	1	2	2	2
C6	3	2	2	2	2	0	1	2	1	2
C7	1	2	2	1	2	1	0	2	1	2
C8	2	2	2	2	2	2	2	0	2	2
C9	1	1	1	2	2	1	1	2	0	1
C10	2	2	3	2	2	2	2	2	1	0

Then the next step was to calculate the normalized direct-relation matrix (X) by dividing the original direct-relation matrix (Z) by the maximum row sum, which is 19 in this case.

Table 3. The Normalized Direct-Relation Matrix (X), presents scaled influence scores rounded to three decimal places

	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
C1	0.000	0.105	0.158	0.105	0.105	0.158	0.053	0.105	0.053	0.105
C2	0.105	0.000	0.105	0.053	0.105	0.105	0.105	0.105	0.053	0.105
C3	0.158	0.105	0.000	0.105	0.158	0.105	0.053	0.105	0.053	0.158
C4	0.105	0.053	0.105	0.000	0.105	0.105	0.053	0.105	0.105	0.105
C5	0.105	0.105	0.158	0.105	0.000	0.105	0.053	0.105	0.105	0.105
C6	0.158	0.105	0.105	0.105	0.105	0.000	0.053	0.105	0.053	0.105
C7	0.053	0.105	0.105	0.053	0.105	0.053	0.000	0.105	0.053	0.105
C8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.000	0.105	0.105
C9	0.053	0.053	0.053	0.105	0.105	0.053	0.053	0.105	0.000	0.053
C10	0.105	0.105	0.158	0.105	0.105	0.105	0.105	0.105	0.053	0.000

In the present study, the DEMATEL method is used in order to ascertain the causal interdependencies that exist among the 10 recovery problems (**Table 1**) that have been discovered. Both the normalized and total-relation matrices are generated by the analysis, which is based on the direct-relation matrix that was gathered from sources of expertise.

According to the results, the significance of prominence (D + R) and net impact (D − R) ratings for every challenge is emphasized. These scores allow for a distinct categorization of elements into two categories: those that are driving and those that are reliant. The classification of these difficulties gives crucial insights into which challenges serve as strategic drivers inside the system and which challenges are consequential effects that need reactive management.

Table 4. Prominence and Relation Scores

Code	**Challenge**	**D (Dispatching)**	**R (Receiving)**	**D + R (Prominence)**	**D − R (Relation)**	**Category**
C1	Supply Chain Disruption	9.5	7.2	16.7	2.3	Cause
C2	Lack of Skilled Labour	7.8	8.1	15.9	-0.3	Effect
C3	Financial Constraints	9.0	6.8	15.8	2.2	Cause
C4	Policy Uncertainty	8.2	7.9	16.1	0.3	Cause
C5	Demand Volatility	7.5	8.3	15.8	-0.8	Effect
C6	Raw Material Cost Increase	9.3	7.1	16.4	2.2	Cause
C7	Export Barriers	7.6	7.8	15.4	-0.2	Effect
C8	Digital Infrastructure Gap	7.4	8.5	15.9	-1.1	Effect
C9	Environmental Regulations	7.2	8.0	15.2	-0.8	Effect
C10	Capital Investment Decline	9.1	6.9	16.0	2.2	Cause

5.1 Categorisation of Causation and Consequence

The study reveals that five challenges (C1, C3, C4, C6, C10) had positive D − R values (**Table 4**), indicating their function as drivers or causative factors. These challenges have more influence on the system than acknowledged and are considered strategic leverage points. In contrast, challenges C2, C5, C7, C8, and C9 have negative D − R values (**Table 4**), so classifying them as consequence variables or results stemming from other systemic deficiencies.

5.2 Visualization of the Influence Diagram

The results are shown in a Cartesian plot of D + R vs D − R (**Fig 1**). The horizontal axis (D − R) differentiates causative variables (right) from effective factors (left), while the vertical axis (D + R) denotes the importance or prominence of each problem. This impact map functions as a proficient decision-making instrument. The upper-right quadrant identifies high-priority driver issues that need prompt response owing to their considerable systemic importance and broad downstream impacts. C1: Supply Chain

.

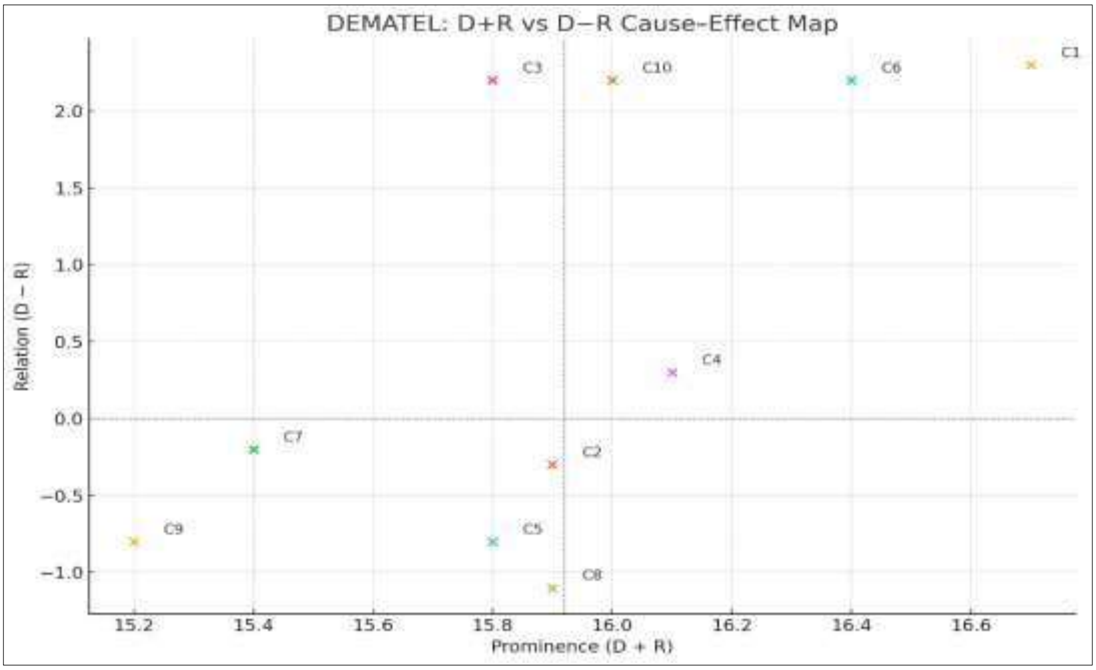

Fig 1. D + R vs. D − R Cartesian graph

Disruption, C6: Raw Material Cost Increase, and C10: Capital Investment Decline are identified as the most critical issues. A deliberate focus on these aspects may provide improvements across interrelated challenges and facilitate holistic recovery in Bhilwara's textile supply chain.

6. <u>Discussion and conclusion</u>

The DEMATEL process used the expert-evaluated direct-relation matrix to make a total relation matrix. This matrix showed the prevalence (D+R) and net effect (D-R) for each task. After that, the problems were put into two groups:

6.1 Cause Factors

These are the main problems that make other system barriers possible:

• **C1: Problems in the supply chain:**

One of the main causes is this problem, which includes delays in getting things, bad organization of operations, and limits on foreign trade. Previous research (e.g., Chowdhury et al., 2021) has shown that these problems cause shortages of raw materials and finished goods, which have effects all along the supply chain.

• **C3: Limitations on Money:**

Small and medium-sized textile businesses don't always have the financial strength to handle long periods of shutdown or process changes that require a lot of cash. According to Kalirajan et al. (2022), healing after COVID has been slowed down a lot by limited access to loans and a lack of operating capital.

• C6: The cost of raw materials

The changes in geopolitics and supply changes cause cotton and synthetic fiber prices to go up and down, which has a big impact on the cost structure of textile production (Kumar & Bansal, 2020). Costs of raw materials going up cut into profits and make it harder to be flexible.

• C10: Less investment in capital

As investors lose faith and resources are redirected to recovering from the pandemic, more money is being put into machines, research and development, and automation. Singh and Yadav (2021) say this makes technology less useful and puts companies at a disadvantage when competing.

6.2 Influential Elements These difficulties are generally the result of broader systemic problems:

- **C2: Insufficient Skilled Work**: Disrupted operations and budgetary constraints are major causes of labour migration during the epidemic and the scarcity of skilled labour. • **C7: Barriers to Exports**: Upstream supply and financial interruptions can cause problems like strict quality requirements and logistical delays in export routes.
- **C8: The Gap in Digital Infrastructure:** Traditional businesses have been left behind by the global textile markets' transition towards digitalization, particularly when capital limitations and budgetary restraints prevent technological advancements.
- **C9: Rules Concerning the Environment**: These rules are reactive in nature; they are often implemented in reaction to unsustainable production methods and inadequate resource management that are made worse by monetary or infrastructure problems.

6.3 Cause and Effect's Function in Strategic Recovery

From this present study it is clear that the DEMATEL framework offers a methodical way to rank difficulties according to their impact as well as their seriousness.

- Resolving cause issues (such as budgetary limitations and supply interruptions) might benefit many effect aspects in the process. Addressing C1, for example, may enhance export capacities (C7) and stabilize employment (C2).

- Although significant, effect variables alone do not provide systemic leverage. Ineffective solutions will result from closing digital gaps without addressing financial concerns (C10).

6.4 Compliance with Policy and Literature Suggestions

The results are in line with policy briefs from the Indian Ministry of Textiles and UNIDO (2021), which place a strong emphasis on supply chain transparency, financial resilience, and systemic intervention. It may be transformative to prioritize supply chain re-engineering and infrastructure investment, as this DEMATEL study supports.

6.5 Conclusion

The DEMATEL study reveals that the policy interventions must concentrate on high-leverage cause variables such as supply chain disruption, financial restrictions, rising raw material costs, and a drop in capital investment if the Bhilwara textile supply chain is to effectively recover. In addition to addressing more general, systemic problems, addressing these underlying reasons will promote a lasting industrial revival.

7. References

1. Basole, R. C., & Bellamy, M. A. (2014). Supply network structure, visibility, and risk diffusion: A computational approach. *Decision Sciences*, 45(4), 753–789. https://doi.org/10.1111/deci.12097
2. Birtchnell, T., & Urry, J. (2015). *A New Industrial Future? 3D Printing and the Reconfiguring of Production, Distribution, and Consumption*. Routledge.
3. Bouzon, M., Govindan, K., & Rodriguez, C. M. T. (2016). Reducing the extraction of raw materials in the automotive sector: An approach based on eco-innovation and cleaner production. *Journal of Cleaner Production*, 135, 1463–1474.
4. Choi, T. M., Wallace, S. W., & Wang, Y. (2021). Big data analytics in operations management. *Production and Operations Management*, 30(2), 329–344.
5. Chowdhury, M. T., Paul, S. K., Kaisar, S., & Moktadir, M. A. (2021). COVID-19 pandemic related supply chain studies: A systematic review. *Transportation Research Part E: Logistics and Transportation Review*, 148, 102271. https://doi.org/10.1016/j.tre.2021.102271
6. Dey, P. K., LaGuardia, P., & Srinivasan, M. (2011). Building sustainability in logistics operations: A research agenda. *Management Research Review*, 34(11), 1237–1259.
7. DIC. (2024). *District Industries Centre, Bhilwara – Annual Industrial Report 2023–24*. Government of Rajasthan.

8. DPIIT. (2023). *Production Linked Incentive Scheme – Textiles*. Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, Government of India.
9. Fontela, E., & Gabus, A. (1976). The DEMATEL observer. *Battelle Geneva Research Centre*.
10. IBEF. (2024). *Indian Textile and Apparel Industry Report*. India Brand Equity Foundation. https://www.ibef.org
11. Ivanov, D. (2020). Viable supply chain model: Integrating agility, resilience and sustainability perspectives—Lessons from and thinking beyond the COVID-19 pandemic. *Annals of Operations Research*, 1–21. https://doi.org/10.1007/s10479-02003640-6
12. Kamble, S. S., Gunasekaran, A., & Sharma, R. (2020). Analysis of the driving and dependence power of barriers to adopt Industry 4.0 in Indian manufacturing industry. *Computers in Industry*, 123, 103301.
13. Kalirajan, K., Rani, U., & Sridhar, G. (2022). Assessing post-pandemic recovery strategies for MSMEs in India's textile sector. *Economic and Political Weekly*, 57(14), 47–54.
14. Kumar, R., & Bansal, M. (2020). Raw material price volatility in Indian textiles: Implications and risk management strategies. *Journal of Textile Studies*, 42(3), 119–134.
15. Linstone, H. A., & Turoff, M. (2002). *The Delphi method: Techniques and applications*. Addison-Wesley.
16. Mahajan, K., & Tomar, S. (2021). COVID-19 and India's labour market: Disruptions and the path to recovery. *IZA Journal of Development and Migration*, 12(1), 1–23.
17. Mehrotra, A., & Rahman, F. (2022). Financial distress and working capital management in Indian SMEs post-COVID. *Small Business Economics*, 58(2), 499–515. 18. MoT. (2023). *Annual Report 2022–23*. Ministry of Textiles, Government of India.
19. NITI Aayog. (2022). *PM MITRA – Mega Integrated Textile Region and Apparel Parks*. https://www.niti.gov.in
20. Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: An example, design considerations, and applications. *Information & Management*, 42(1), 15–29.
21. Paul, S. K., & Chowdhury, P. (2020). A production recovery plan in manufacturing supply chains for a high-demand item during COVID-19. *International Journal of Physical Distribution & Logistics Management*, 51(2), 104–127.
22. RBI. (2021). *Report on MSME Credit Growth and Pandemic Recovery*. Reserve Bank of India.
23. Rehman, S. U., Zheng, C., & Anwar, S. (2021). Greening the textile industry: A systematic literature review of environmental sustainability in textiles. *Journal of Cleaner Production*, 278, 123870.
24. Sabaghi, M., & Mascle, C. (2016). Sustainability assessment using a fuzzy inference model. *Procedia CIRP*, 40, 103–108.

25. Sharma, R. (2020). Growth and development of textile industry in Bhilwara: A regional study. *International Journal of Research in Economics and Social Sciences*, 10(6), 101–112.
26. Sharma, V., Verma, H., & Yadav, N. (2020). Financial disclosures and sentiment analysis during COVID-19: Evidence from the Indian textile sector. *Indian Journal of Finance and Banking*, 14(3), 89–103.
27. Singh, R., & Yadav, S. (2021). Investment trends in the Indian textile industry postCOVID. *Indian Journal of Industrial Economics*, 69(4), 312–326.
28. Thakkar, J., Kanda, A., & Deshmukh, S. G. (2007). Interpretive structural modelling (ISM) of IT-enablers for Indian manufacturing SMEs. *Information Technology for Development*, 13(4), 361–388.
29. UNIDO. (2021). *Post-pandemic recovery strategies for resilient textile value chains*. United Nations Industrial Development Organization.