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Exploring Barriers in Achieving Supply Chain Resilience in Indian MSMEs

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Abstract

Today's business environment is uncertain, and businesses from emerging countries require resilient supply chains (SCR) to sustain their operations and be competitive in the environment. In particular, MSMEs (Micro Small and Medium Enterprises) play a key role by unlocking their potential in creating employment, enhancing innovation, promoting regional development, and contributing to GDP. This study addresses the barriers affecting resilient supply chain implementation among the MSMEs from the Indian context. Further, the study also examined the barriers interdependencies by deploying Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach to systematically map the cause–and–effect relationships among the barriers. The findings of the study reveal the key barriers to resilience implementation are Lack of Financial Resources, Lack of Management Support, Inadequate Digital Infrastructure, Lack of Collaborative among the supply chain partners, Communication Barriers, Lack of skilled workforce, Resistance to Change, Supplier Dependency, Lack of government regulation, Cultural Barriers, Lack of Risk Awareness & Planning and, Gap between strategic planning and operational actions. The results help practitioners and MSME entrepreneurs to improve supply chain resilience and ensure long-term competitiveness.

Keywords
Supply chain, Resilience, Barriers, MSMEs, DEMATEL

1. Introduction
In the interconnected world supply chain acts as a backbone for commerce (Vidza, M. Budka, W.K. Chai et al. 2025). Products demanded by consumers are produced and distributed using supply chains made up of raw material suppliers, factories and production facilities, as well as distribution facilities that supply retail locations with goods for consumers to purchase. In the past several decades, supply chains have become more geographically dispersed due to the opening of new markets, faster flows of information, and cheaper, more

reliable and efficient transportation costs (Chopra and Sodhi, 2014; Christopher and Holweg 2017). Traditional supply chains have a linear sequence of processes: production to distribution. Modern supply chains are better understood as complex networks, consisting of numerous interlinked entities such as manufacturers, suppliers, distributors, and consumers. These entities interact through multidirectional flows of materials, information, and capital and often include feedback loops and decentralised control (Min and Zhou, 2002; Mentzer, John T., et al., 2001); (Christopher and Peck 2004). Recently, supply chains have become more vulnerable and increasingly affected by a growing number of disruptions that significantly impact their operations. This vulnerability stems from various causes, such as excessive leanness and efficiency (Pettit et al., 2010), over the past five years. Causes for global supply chain disruptions include, e.g., natural disasters, financial crises, and terrorist attacks. In 2020, COVID-19 unleashed a global pandemic, killing millions of people and disrupting supply chains around the world in ways we even now continue to grapple with (Ali et al., 2022; Ivanov, 2020; L´opez et al., 2022). A report stated that 94 % of Fortune 1000-listed companies were affected by supply chain disruptions during the early stages of the pandemic (Sherman, 2020). Worker shortages due to health and safety issues led to unplanned and unexpected capacity shortfalls, which in turn affected other parts of the supply chain when material, e.g., from suppliers, could not be received in time. Transportation nodes were also affected by personnel shortages, which led to both an increase in the lead time as well as an increase in the variability of the lead times. Digitalisation and the development of strategies allowed organisations to overcome these effects on supply chains (Brookbanks and Parry, 2024; Ivanov, 2021; Ivanov and Dolgui, 2020).

Micro, Small, and Medium Enterprises (MSMEs) are also the backbone of Indian economy, since they provide a huge contribution to GDP of 30%, employs more than 110 million workers, and improving regional development (OECD, 2019; Ministry of MSME, 2023) making these enterprises critical to industrial development and socio-economic stability (Government of India, 2023). Because of structural limitations, these enterprises are prone to supply chain disruption, including limited financial capital, inability to invest in technologies and dependence on suppliers (Gunasekaran et al., 2011; Mathivathanan and Sivakumar, 2021).

Supply chain resilience (SCR) has emerged as a key capability for increasing supply chain performance in today's business environment in reaction to the frequent and unpredictable disruption. SCR is the ability of a supply chain to prepare for such unexpected events, respond effectively, and recover operations to an acceptable performance level while maintaining network connectivity and control (Christopher and Peck, 2004; Sheffi, 2015). Unlike traditional risk management, which focuses on specific threat mitigation, resilience emphasizes adaptability, agility, and recovery speed under diverse disruption scenarios (Wieland and Durach, 2021). The alarming conditions, such as constant change, shorter product life cycles, diverse customer requirements, and increased uncertainty on customer demand (Gligor et al, 2015) faced by businesses. McKinsey Global Supply Chain Leader Survey (2024) shows that from 2020 to 2022, resilience initiatives grew rapidly at 7% per annum due to post-pandemic disruptions. Large enterprises have the resources to implement resilience-enhancing strategies such as redundancy, agility, and advanced digital integration. Where MSMEs frequently encounter significant barriers that acted as a road block for such adoption (Sawyerr and Harrison, 2020).

This research reveals several barriers to SCR in MSMEs. These barriers include lack of financial resources, risk assessment, supply chain visibility, lack of support from senior management, poor collaboration with supply chain partners, and limited organisational culture for change (Ali et al., 2017; Hohenstein et al., 2015; Chowdhury et al., 2019). While some barriers are independent, many are interdependent and reinforce each other. For example, a lack of financial resources leads to fewer investments in digital technologies, hence poor visibility and slower decisions in a crisis (Dubey et al., 2021). Similarly, a lack of trust and collaboration between partners has limited the dissemination of trust, inventory, or risk information and therefore has reduced the ability to act together (Kumar, 2020). Much of the SCR literature focuses on larger firms, but there has been little research into the role of MSME, specifically those in an emerging economy context, who are exposed to an external environment that adds to their vulnerability such as poor infrastructure and regulatory barriers. (Mathivathanan et al., 2018). Very few studies have actually examined the interdependencies between the barriers to determine which were more critical in terms of affecting resilience performance. The lack of knowledge inhibits the development of targeted and evidence-based approaches to challenging barriers and developing the resilience of MSMEs.

To address this gap, the current study aims to provide a systematic analysis of barriers to SCR implementation in MSMEs, examine their interdependencies, and suggest possible mitigation strategies. The study will address the following Research Questions (RQs):

RQ1: What are the main barriers to implementing resilient supply chain management in MSMEs?

RQ2: What are the interdependencies among these barriers? What causal relationships exist among the different barriers?

The aims of this study include two objectives. The first is to identify the significant barriers to suggest risk interventions available to effectively perform SCR practices in Micro, Small, and Medium Enterprises (MSMEs). The second aim is to examine the interdependencies and relationships between the barriers to SCR to understand what influence some barriers may have on the others.

By addressing the objectives, this study will assess the literature on (SCR), the evolution, and significance of MSMEs in supply chains and discuss the challenges and literature gaps specifically from an Indian perspective. It identifies the critical barriers and highlights the research Gaps in MSME-focused resilience studies. The methodology employed to analyse the interdependencies among the 12 key barriers was DEMATAL, and the data for the same were collected from the experts belonging to MSMEs. Results classify barriers into cause-and-effect groups and reveal the primary drivers for systematic vulnerabilities. Theoretical and managerial implications are discussed. The research aims to make both theoretical and practical contributions—advancing scholarly understanding of barrier dynamics in MSME supply chains, while offering actionable insights for managers, policymakers, and industry associations to foster more resilient and sustainable MSME operations.

2. Review of Literature

The following literature review can provide an overall view of the basic concepts of SCR and its impact on Micro, Small and Medium Enterprises (MSMEs). This section focuses on the diverse view of existing literature on the development of resilience concepts, barriers and factors influencing resilience for MSMEs. The reviews taken from most of the sources examine, the evaluation and determinants of resilient supply chains, resilience challenges in MSMEs, barriers and enablers of MSMEs SCR.

2.1 Resilient Supply Chains

Over the past two decades, SCR has evolved considerably and gained significance as a strategic solution in response to global supply chain disruptions. SCR had emerged from risk management, particularly supply chain risk perspectives, in the early 2000s. The concept further evolved and took a more systematic form as the subsequent crisis exposed its inherent vulnerabilities and practical significance. (Ivanov and Dolgui, 2020; Negri et al., 2021). The global pandemic COVID-19 has increased these vulnerabilities and risk in supply chain, causing operational stagnation and took ‘V’ shaped recoveries in all the industries and fortified the importance of resilient supply chain systems, which is capable of absorbing the shock and restores the functions (Spieske and Birkel, 2021). In developing countries, SCR has become important to face the disruption and is part of the operational strategies to improve the supply chain performance. (Aman and Seuring, 2021). This SCR is conceptually structured across four significant stages such as: readiness, response, recovery, and renewal, each states representing key strategic dimensions such as: emphasising planning, stabilisation, restoration, and continuous improvement. These dimensions benefit the organisations to prepare proactive planning, enhances responsiveness during crisis, continuity of operation after disturbances and integrating the leaning in future strategies (Chaffin et al., 2024).

MSMEs are very significant for their contribution to any country’s economy, their supply chain also exposed to vulnerabilities in different proposition due to their limited scale and constrained resource base. The resource constraint and scale of operation of MSMEs often hinder the risk management and resilient capability in their supply chain (Ali et al., 2017; Bak et al., 2020). These constraints and its influence in risk management have received comparatively limited attention. This is because the contribution of individual MSMEs to original equipment manufacturers (OEMs) is often small. However, the collective contribution of MSMEs in supply network can substantially influence the SCR. (Queiroz et al., 2022; Ali et al., 2021). Enterprise capacity and collaborative resources are the two main dimensions that are significant to managing resilience of MSMEs and enable coordination and integration with their supply chain partners. (Ali et al., 2017). It is known and common that MSMEs face the limitations to respond the disruptions due to limited material, manpower and financial resources (Bak et al., 2020; Zhong et al., 2024). These limitations are further intensified by the system-related challenges, including a lack of policy, immediate government support and guidance (Halkos et al., 2018); Many MSMEs face recurrent financial instability, unable to access immediate loans or credit facilities during the disruptions (Banerjee et al., 2022). Moreover, lack of leadership qualities and commitment to face the crisis, often curtail the development of the strategies to encounter the risk in supply chain of MSMEs (Agarwal et al., 2022; Singh et al., 2018).

The major impediments faced by MSMEs' resilience are insufficient funding in research and development, poor adoption of information technology and limited managerial autonomy (Ali et al. 2017). In addition to mentioning

that collaborative capabilities, agile capabilities and lack of empowerment are barriers that can hinder resilience (Agarwal et al., 2022). Some of these limitations are the result of the limited financial support and resources for MSMEs. The delay in development and implementation of government polices to support MSMEs further disrupts their resilience in the supply chain (Phan et al. 2023). In developing countries like India, the MSMEs' SCR is also facing similar barriers mentioned earlier, mostly related to legal, finance, technology and leadership (Yontar 2025). Recently, digitalisation using technologies such as Artificial Intelligence, Internet of Things (IoT), supply chain visibility tools and blockchain are enhancing SCR in most of the companies. (Shakur et al., 2024; Bazile et al., 2025). These digital tools supporting SCR may not be essential and, in some cases, affordable to MSMEs to utilise its benefits to gain resilience in supply chain. Moreover, the digital skill level of the workforce and the leadership support for digitalisation are also a challenge for MSMEs (Bentaher and Rajaa, 2022; Wang and Huang, 2025). Partners of MSMEs, particularly suppliers and original equipment manufacturers, may demand that MSMEs improve their digitalisation capability; they are getting support and enabling resource pooling during disruptions (Nakandala et al., 2025; Orlando et al., 2021; Ogunsoto et al., 2025). Thus, it is important to analyse that the barriers that hinder the resilience of MSMEs' supply chain is also cascading to their partners immediately connected to them and finally to the entire supply network.

The following Table 1 depicts the key findings from the literature, which describes the glossary of the barriers identified related to SCR.

Table 1. Resilient supply chain

Author(s) and Year	**Key Findings from the literature**
Ivanov and Dolgui (2020); Negri et al. (2021)	SCR emerged as a distinct concept around 2003, evolving from supply chain risk and risk management perspectives
Chaffin et al. (2024)	SCR is broadly categorised into four phases: readiness, response, recovery, and renewal, emphasising planning, stabilisation, restoration, and continuous improvement
Spieske and Birkel (2021)	The global pandemic COVID-19 has resulted in major disruptions, caused the most of the companies temporarily stop their operations and created major disruption in the supply chain
Aman and Seuring (2021)	In developing countries, SCR represents a significant part the operational strategy of an organisation with extensive impact for supply chain performance.
Ali et al. (2017)	MSMEs identified three major SCR hurdles such as: stringent IT adoption ability, limited research & development funds and lack of management autonomy, leads MSMEs vulnerable and face challenges in managing risks
Bak et al. (2020); Zhong et al. (2024)	Due to limited capacity and operational contingencies of MSMEs, they are facing response problems regarding human, material, and financial resources
Queiroz et al. (2022); Ali et al. (2021)	MSMEs have got quite little attention in SCR related discussions despite their substantial contribution to economic stability
Halkos et al. (2018)	Identified the lack of policy, guidance, and support from the government as a critical barrier for SMEs
Banerjee et al. (2022)	Lack of financial resources to obtain urgent loans is identified as a significant barrier to SME resilience
Agarwal et al. (2022); Singh et al. (2018)	Limited top management support, commitment from senior management and empowerment impede resilience

Phan et al. (2023)	Limited alternative sources of supply of materials and financial resources are the gravest barriers; there is a delay from the government in developing supportive measures that are also critical
Yontar (2025)	Legal uncertainties and lack of incentives, financial difficulties, and technological immaturity are the most influential root barriers in developing economies
Shakur et al. (2024); Bazile et al. (2025)	Industry 4.0 technologies (IoT, AI, blockchain) enhance end-to-end visibility and demand forecasting, recognised as key to SCR
Bentaher and Rajaa (2022); Wang and Huang (2025)	Strong leadership, a digitally skilled workforce, organisational culture, and IT infrastructure are recognised as critical enablers enhancing agility during disruptions
Nakandala et al. (2025); Orlando et al. (2021)	Cooperation with supply chain partners improves coordination, reduces uncertainty, and enables resource pooling during disruptions
Ogunsoto et al. (2025)	Studies examining resilience barriers in emerging economies remain limited, particularly for MSMEs

2.2 Resilience in Indian MSME

In India, the pursuit of SCR among MSMEs is an ever-constant challenge formed by structural, technological, structural and institutional constraints. The global scenario also acknowledges the strategic importance of resilience in MSMEs. In developing economies, MSMEs often faces a diverse no of systemic barriers, which hinder their ability to absorb distribution and continue in operations. As per World Bank (2023) report, in developing economies, nearly 72% of MSMEs are reported with significant supply disruption in the past three years, primarily due to raw material short supply, political instability of a country, and logistics disruption. MSMEs in India remains remain reactive to disruptions rather than building adaptive capacities, it may be due to a lack of managerial expertise and technological (Muniroh et al. 2025).

Indian MSMEs has poor digital transformation facilities, which leads to lack of supply chain visibility and flexibility. High implementation cost of these facilities and resistance to adapt the new technologies hiders its adoption. (Kumar et al., 2025; Sahoo et al., 2025; Agarwal et al. 2022). Due to fragmented supply networks and limited skilled work force are the major threat to digital initiatives to MSMEs remain uneven and unsustainable. As per FICCI–Deloitte 2024 report related to Resilience Index values, it is evident that 47% of Indian manufacturing MSMEs are in still facing severe disruptions from material price volatility and from the remaining only 29% have adopted digital supply chain tools such as IoT-based inventory monitoring or predictive analytics. MSMEs in India are also prone to supply chain fragility like logistics inefficiencies and regulatory complexities, the partnering firms give pressure to adopt their logistics standards, which affects their long-term stability (Gaurav Khanna and Nicolas, 2022; NITI Aayog, 2025; Gamage et al. 2020: Singh and Kumar 2020). Thus, addressing these challenges and advancements requires a comprehensive study that assess the digital readiness, institutional support, and risk governance across the Indian MSME ecosystem (Table 2).

Table 2. Resilience in Indian MSME

Author(s) and Year	**Key Findings from the Literature**
World Bank (2023)	In developing economies reported that around 72% of MSMEs have reported at least one major supply disruption in the past three years due to raw material shortage, political instability, and logistics impediments.
Mishra et al. (2023)	Identified limited resource availability, weak internal coordination, and reliance on traditional processes as major barriers to MSME resilience.
Shekarabi et al. (2025)	Most small enterprises remain reactive rather than proactive due to lack of technological literacy and managerial expertise.

Kumar et al. (2025); Padovano et al. (2024)	Digital transformation improves supply chain visibility and flexibility; however, adoption is hindered by high implementation costs, inadequate infrastructure, and workforce limitations.
Agarwal et al. (2022)	Post-pandemic digital initiatives in MSMEs often fail due to fragmented supply networks and a lack of skilled workforce to leverage advanced tools.
World Economic Forum (2025); OECD (2025)	MSME digitalisation efforts remain uneven and unsustainable without targeted policy interventions and financial support.
FICCI–Deloitte Resilience Index (2024)	In Indian manufacturing MSMEs, particularly 47% of them faces disruptions in their operations due to material price volatility and energy shortages , the 29% of remaining have adopted digital supply chain tools such as IoT-based inventory monitoring.
Gaurav Khanna and Nicolas (2022); NITI Aayog (2023, 2025)	Logistical inefficiencies, regulatory complexities, and poor access to finance exacerbate supply chain fragility in Indian MSMEs.
Gamage et al. (2020); Singh and Kumar (2020)	Globalisation pressures increase competition for MSMEs, affecting long-term stability and resilience efforts.

2.3 SCR Barrier's identification

The barriers identified to SCR are majorly from the structural, operational, technological, institutional and finance related obstacles, which gives disruptions to supply chain and operations of the company (Pettit et al., 2019; Mathivathanan and Sivakumar, 2021). In Indian Micro, Small, and Medium Enterprises (MSMEs), these barriers encompass internal limitations such as lack of digital readiness, weak coordination, inadequate resources, and poor risk management practices, as well as external constraints including regulatory complexities, supply chain dependencies, and limited access to finance and infrastructure (Sahoo et al., 2025; Mishra et al., 2023). Collectively, these barriers reduce the adaptive capacity of MSMEs, making their supply chains more vulnerable to disruptions caused by geopolitical instability, market volatility, or environmental changes.

The barriers have been identified with the existing literature in Web of Science and Scopus. Initially, 25 barriers were identified with the help of expert opinion the barriers have been narrowed down to 12 barriers. However, barriers to the effective practice of resilience in micro, small, and medium enterprises (MSMEs) are complex, intertwined, and perceived in some cases as risks in themselves. Table 3 shows the identified twelve categories of barriers applicable to MSMEs.

Table 3. Identified Barriers

S. No.	Barriers	Description	Key References
1	Lack of Financial Resources	Limited capital restricts investment in redundancy, technology, skills, and contingency planning, widening the resilience gap between MSMEs and large firms.	Afsar et al., 2024; Machado et al., 2025; Agarwal et al. (2024); Singh et al. (2025)
2	Lack of Management Support	Low executive commitment reduces prioritisation, resource allocation, and drives other barriers such as weak collaboration and poor planning.	Agarwal and Seth, 2021; Seker and Aydin, 2024; Afsar et al. (2024); Agarwal et al. (2024); Singh et al. (2025)
3	Inadequate Digital Infrastructure	Outdated ICT systems and minimal automation hinder visibility, data sharing, and	Machado et al., 2021; Seker and Aydin, 2024; Agarwal et al. (2024)

		predictive capabilities essential for resilience.	
4	Lack of collaboration among supply chain partners	Low trust, reluctance to share data, and misaligned objectives weaken joint problem-solving and coordinated disruption response.	Afsar et al., 2024; Ali et al., 2017
5	Communication Barriers	Fragmented communication channels and inconsistent information exchange delay decision-making and reduce agility.	Afsar et al., 2024; Agarwal and Seth, 2021; Agarwal et al. (2024)
6	Lack of Skilled Workforce	Shortages of staff trained in analytics, risk management, and technology use hinder resilience-building initiatives.	Machado et al., 2021; Seker and Aydin, 2024
7	Resistance to Change	Employee apprehension towards new technologies and fear of job loss slow resilience adoption, especially in Supply Chain 5.0 contexts.	Kumar and Singh, 2025; Gupta et al (2022); Agarwal et al. (2024)
8	Supplier Dependency	Over-reliance on single suppliers increases vulnerability to upstream disruptions and limits flexibility.	Afsar et al., 2024; Agarwal and Seth, 2021
9	Lack of Government Regulation and Support	Absence of targeted policies, incentives, and supportive frameworks reduces MSMEs' capacity for resilience investment.	Machado et al., 2021, Wang et al., 2024
10	Cultural Barriers	Hierarchical decision-making, siloed operations, and low trust reduce willingness to share risk information and collaborate.	Agarwal and Seth, 2021, Afsar et al., 2024
11	Lack of Risk Awareness and Planning	Absence of structured risk assessment and contingency planning leads to reactive rather than proactive disruption responses.	Ali et al., 2017; Agarwal and Seth, 2021
12	Gap Between Strategic Planning and Operational Actions	Strategic resilience goals fail to translate into operational practices due to a lack of clear implementation roadmaps.	Agarwal and Seth, 2021; Seker and Aydin, 2024; Agarwal et al. (2024); Kumar and Singh (2024)

The following is the definition of the barriers identified from the various literature for a period in Indian MSMEs which disrupts the SCR

1. **Lack of Financial Resources**
   Insufficient financial capital is a basic barrier for MSMEs. Limited liquidity hampers investments in redundancy, technological upgrades, and contingency considerations, which are all important functions of resilience (Afsar, Ahamed, and Sarker, 2024; Machado, Scavarda, Caiado, and Thomé, 2021). Where Industry 4.0 technologies can improve resilience, upfront costs further perpetuate the divide between small and large firms (Machado et al., 2021). This barrier also extends to hiring skilled staff, managing supplier diversity, and maintaining safety stock.
2. **Lack of Management Support**

The commitment of top management is an important driver of supply chain resiliency (SCR) initiatives. Indian automotive sector that executives' inattention serves as a "driving barrier" that exacerbates other impediments, such as poor collaboration and a lack of risk planning (Agarwal and Seth 2021). Health care supply chain in a company has identified low commitments from managers as the most their major barrier to digital transformation (Seker and Aydin 2024).

3. **Inadequate Digital Infrastructure**
   Often, MSMEs failed to have the resources and facilities to have the sophisticated system which may lead to inadequate automation and data integration, which are all lead to limited visibility and quick decision-making. This so-called "digital gap" limits information sharing and predictive activity that is needed for SCR (Machado et al., 2021) and has also been shown to delay disruption detection and recovery in the healthcare supply chain sector due to technology limitations (Seker and Aydin, 2024).

4. **Lack of Collaboration Among Supply Chain Partners**
   Coordinated risk mitigation is essential for collaborative inter-firm implications, but research shows MSME frequently face trust issues, misaligned goals, and resistance to sharing sensitive information (Afsar et al., 2024; Ali, Nagalingam, and Gurd, 2017). Within the Bangladeshi food sector, inadequate supplier collaboration was one of the most significant barriers to SCR practices (Afsar et al., 2024).
5. **Communication Barriers**
   During crises, fragmented communication channels and inconsistent information sharing limit the agility of MSMEs. Inconsistent communication delays decision making in addition to creating deviations in lead time (Afsar et al., 2024; Agarwal and Seth, 2021). Technological and human communication processes are required to enhance resilience.
6. **Lack of Skilled Workforce**
   Human capital deficits, especially in relation to analytics, risk management and use of digital technology, are barriers to building resilience (Machado et al., 2021). The health care sector similarly notes that insufficient digital worker skills are barriers to the adoption of resilience-enhancing platforms (Seker and Aydin, 2024).
7. **Resistance to Change**
   SCR initiatives are commonly stalled by cultural inertia and employee resistance to technological adoption. Application of research in Supply Chain 5.0 adoption shows that employees typically resist change due to fear of job loss and uncertainty about the benefits of the technology (Kumar and Singh, 2025). Employee resistance and concern towards technology are expected to be even more significant in contexts that rely on human and machine collaboration.
8. **Supplier Dependency**
   A current dependence on only one or several suppliers increases the chances of being affected by a upstream shock. Research in both sectors involving food (Afsar et al., 2024) and automobiles (Agarwal and Seth, 2021) shows dependence restricted flexibility and risk diversification/ even when alternative sourcing strategies are in place.
9. **Lack of Government Regulation and Support**
   The lack of targeted polices, incentives and enabling regulations means that MSMEs are unable to make investments in resilience. Machado et al. (2021) have mentioned that there is a low level of government enablers for Industry 4.0 adoption in MSMEs. In the food sector, the government business support during a crisis, tends to be ineffective to the realities of the operations (Wang et al.,2024).
10. **Cultural Barriers**
    Organisational cultures that are defined by hierarchical decision-making, siloed operations and low trust, create organisations that lack collaborative risk management (Agarwal and Seth, 2021). Cultural misalignments between partners in multi-tier supply chains could impede coordination and resource sharing activities (Afsar et al., 2024).
11. **Lack of Risk Awareness and Planning**
    In many MSMEs, proactive risk management is often absent, leading to crisis responses that are reactive in nature. Ali et al. (2017) found that food supply chains associated with perishable goods and lacking structured risk assessment suffered disproportionately during disruptions. Likewise, in the automotive sector, noted prolonged recovery durations without formal risk monitoring frameworks (Agarwal and Seth 2021).

12. **Gap Between Strategic Planning and Operational Actions**

For resilience adoption, there is a common challenge is the gap between high-level strategy and the operational practices adopted in the lower level. For an instance, in an Indian automotive manufacturing sector the strategic objectives for resilience particularly diversifying suppliers or making contingency plans for emergencies, it is not translated into operational practices such as performance reviews or changing inventories (Agarwal and Seth 2021). In on more case, the operational teams in healthcare company, digital transformation initiatives are often left with a general set of resilience improvement strategies, but without an implementation roadmap or actionable process to rely on if the planned resilience strategies are to succeed Seker and Aydin (2024).

4 Methodology

This study utilizes the Decision-Making Trial and Evaluation Laboratory (DEMATEL) to help unravel and graphically represent the cause–and–effect structure among the barriers to resilient supply chains in Indian MSMEs. DEMATEL incorporates feedback and interdependence, as seen in the MSME ecosystem, where barriers such as financial constraints, digitalization gaps, supplier vulnerability, logistics/infrastructure disruptions, skills shortages, and policy/regulatory barriers interrelate. DEMATEL uses directed graphs (digraphs) to assess, through pairwise influence, the barriers and rank them in driver (cause) and dependent (effect) categories.

The recent applications provide evidence that DEMATEL is an appropriate analysis method for resilience. For instance, Banerjee et al. (2023) applied a grey-DEMATEL approach to Indian MSMEs to identify the barriers that their organizations faced in a post-COVID context, along with the causal structure of these barriers. Likewise, Das et al. (2022) accepted an AHP-DEMATEL framework to show the function of government support as a major causal driver for resilience during COVID-19. Sarker et al. (2023) applied approximate fuzzy DEMATEL to model resilience drivers in manufacturing, identifying risk management culture and supply base diversity as high-influence drivers. Moreover, other hybrid frameworks, such as fuzzy DEMATLE-ISM, have provided hierarchical relations between resilience enablers within the global supply chain (Sheng et al., 2025). Overall, the findings suggest that DEMATEL provides a prominent base to find the interdependencies of MSME barriers, to design actions and polices directed to the manager's intervention and possibly understand the structural component of barriers which may change or shift as interventions are applied.

4.1 Application of DEMATEL

To evaluate the interrelationships among the barriers that impact SCR in Indian MSMEs, the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was utilized. This method enables barriers to be classified in cause (driving) and effect (dependent) groups, which will then shape policies or managerial approaches. This method is outlined in the following steps:

Step 1: Identify the Expert Panel and define the Criteria

The expertise of the panel includes MSME representatives, supply chain managers, and academic professionals working in SCR, each having many years' experiences. The panels' feedback is presented as a list of barriers (i.e., financial constraints, limited digitisation, weak collaboration, unclear or non-existent policies and linkages, and infrastructure constraints), based on a thorough literature review and conversations with experts, as the barrier list that needs evaluation.

Step 2: Developing the Direct-Relation Matrix

Experts were asked to evaluate the extent to which one barrier influences another using a five-point scale:

0 = No influence, 1 = Low influence, 2 = Moderate influence, 3 = High influence, 4 = Very high influence

Based on the panel's feedback to the question regarding the barrier influence, the average ordering was used as the starting point to develop the initial direct-relation matrix (X), so the element of the original direct-relation matrix, x_ij, is the direct influence of barrier i on barrier j.

$$\begin{bmatrix} x1 & \cdots & x1n \\ \vdots & \ddots & \vdots \\ xn1 & \cdots & xnn \end{bmatrix} \quad \text{Eq 1}$$

Step 3: Normalise the Direct-Relation Matrix To normalise the direct-relation matrix in a way that each element is between 0 and 1. The normalised matrix (N) was calculated as:

$$\frac{x}{max_i \sum_{j=1}^{n} xij} \quad \text{Eq 2}$$

Step 4: Derive the Total Relation Matrix

The total relation matrix (T) was obtained by accounting for both direct and indirect effects among barriers:

$$T = N(I - N)^{-1} \quad \text{Eq 3}$$

where I is the identity matrix.

Step 5: Calculate Prominence and Relation Values

For each barrier, two measures were computed:

$$R_i = \sum_{j=1}^{n} t_{ij} \ \ and\ C_i = \sum_{j=1}^{n} t_{ji} \quad \text{Eq 4}$$

R_i : Total influence exerted by barrier *i* on others.

C_i : Total influence received by barrier *i* from others.

The Prominence (R_i + C_i) represents the overall importance of a barrier, while the Relation (R_i - C_i) determines its causal nature:

If (R_i - C_i) >0, the barrier is a cause (driver).

If (R_i - C_i) <0, the barrier is an effect (dependent).

Step 6: Develop the Causal Diagram

A causal diagram was plotted using (R_i + C_i) on the horizontal axis and (R_i - C_i) on the vertical axis. This visualisation classified barriers into driving factors (e.g., financial constraints, policy uncertainty) and dependent factors (e.g., lack of collaboration, cultural barriers). The results enabled prioritisation of interventions for enhancing MSME SCR.

Step 7: According to the Total relationship matrix A diagraph was drawn using the Dia Software.

5 Case: Interdependencies Among Barriers to SCR in Indian MSMEs

India's MSME sector serves as a vital engine of economic growth, contributing nearly 30% to GDP, 45% to manufacturing output, and 40% to exports. Despite its scale and significance, the sector remains vulnerable to disruptions due to limited financial capacity, supplier dependence, and infrastructural weaknesses. Recognising the need to understand how these challenges interact, this study applied the Decision-Making Trial and Evaluation Laboratory (DEMATEL) methodology to analyse the interdependencies among twelve critical barriers to SCR in Indian MSMEs.

The barriers were identified through an extensive literature review and validated by a panel of five experts from MSMEs in textiles, agri-food processing, and engineering components each with over a decade of experience in supply chain, procurement, or operations. A structured questionnaire was designed to capture the degree of influence of one barrier over another on a 0–4 scale, where 0 indicated no influence and 4 represented very high influence. The experts' evaluations were used to form and average four direct relation matrices, which were normalized to create the direct-influence matrix (D). From this, the total relation matrix (T) was derived to calculate prominence (R_i + C_i) and net influence (R_i - C_i) values.

The findings revealed that financial constraints and poor access to credit made MSMEs particularly sensitive to demand fluctuations and cost volatility. Heavy reliance on a few key suppliers, coupled with minimal digital adoption, weakened visibility and response capability. Inadequate infrastructure and policy unpredictability further aggravated operational risks.

This analysis highlights the interconnected nature of barriers and emphasises the need for targeted resilience-building strategies. Strengthening financial stability, promoting digitalisation, and improving infrastructure can significantly enhance MSME SCR in India.

5.1 Data Collection Process

The expert panel is a diverse mix of professionals from the manufacturing industry in Chennai. The manufacturing industry includes centrifugal pumps, castings, and pharmaceuticals, and the panel is comprised of members working as senior leaders with more than two decades of experience, to young professionals bringing their operational and analytical perspectives. The panel consists of an Industrial Business Head in Centrifugal Pump Manufacturing with 23+ years of experience, two Managing Directors from MSME that operate within the castings industry of 15 years and 8 years of experience respectively to provide strategic-level perspectives, and young professionals like a Procurement Engineer with 3.5 years' experience in pump manufacturing, and a Purchase Officer in the pharmaceutical industry with an MBA in Operations and Business Analytics with 4+ years of experience. The panel represents a blend of Strategic Leadership and Operational experience, including different Functional Perspectives: Supply Chain Management, Manufacturing Operations, Manufacturing, and Business Development. Collectively, the mixture of functional diversity and industry experience will grant the group credible strategic insights and tactical regional insights into the challenges and opportunities present within MSME ecosystems (Table 4).

Table 4. Profile of the Expert Panel

S. No.	Industry	Role / Designation	Experience (Years)
1	Centrifugal Pump Manufacturing	Industrial Business Head	24
2	Castings (MSME)	Managing Director	15
3	Castings (MSME)	Managing Director	8
4	Centrifugal Pump Manufacturing	Risk analyst	3.5
5	Pharmaceutical Manufacturing	Resilient analyst	4

6. Application of methodology

In this phase, the barriers and the influence of the barriers over one another were identified with the assistance of the experts using DEMATEL. As mentioned earlier, the steps involved in the DEMATEL were applied to the above context as follows:

Step 1: Direct relationship matrix. In this step, the barriers identified from the literature and validated by the experts were rated by the experts through a questionnaire. The ratings indicate the influence of one barrier on another. From these ratings, the direct relationship matrix among the identified barriers was obtained and is tabulated in Table 5. Similarly, all the following steps were conducted as outlined in the previous section.

Table 5. Initial direct relationship matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0.000	0.103	0.098	0.080	0.076	0.085	0.063	0.085	0.080	0.049	0.089	0.085
B2	0.103	0.000	0.103	0.098	0.094	0.085	0.076	0.098	0.098	0.080	0.085	0.080
B3	0.076	0.071	0.000	0.085	0.071	0.098	0.076	0.063	0.063	0.076	0.063	0.071
B4	0.089	0.098	0.058	0.000	0.085	0.098	0.076	0.089	0.071	0.080	0.058	0.058
B5	0.063	0.098	0.085	0.094	0.000	0.094	0.089	0.107	0.063	0.080	0.080	0.089
B6	0.098	0.071	0.067	0.071	0.067	0.000	0.098	0.076	0.089	0.085	0.098	0.098
B7	0.076	0.063	0.080	0.094	0.098	0.071	0.000	0.098	0.098	0.067	0.071	0.080
B8	0.089	0.080	0.063	0.076	0.085	0.071	0.063	0.000	0.063	0.054	0.076	0.058
B9	0.094	0.058	0.076	0.071	0.071	0.085	0.071	0.089	0.000	0.063	0.085	0.076
B10	0.058	0.063	0.040	0.063	0.054	0.071	0.076	0.058	0.045	0.000	0.054	0.058
B11	0.098	0.076	0.089	0.085	0.080	0.067	0.063	0.063	0.080	0.071	0.000	0.089
B12	0.071	0.080	0.071	0.089	0.063	0.080	0.080	0.094	0.054	0.049	0.058	0.022

Step 2: Normalised matrix. The initial direct relationship is normalised through the equations. and the normalised matrix (Table 6) is tabulated.

Table 6. Normalised matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	1.48	0.55	0.53	0.55	0.52	0.55	0.5	0.56	0.5	0.45	0.52	0.54
B2	0.62	1.5	0.58	0.61	0.58	0.6	0.55	0.62	0.56	0.52	0.56	0.58
B3	0.51	0.48	1.40	0.51	0.47	0.52	0.47	0.5	0.45	0.44	0.45	0.48
B4	0.55	0.53	0.48	1.46	0.51	0.55	0.49	0.55	0.48	0.46	0.47	0.5
B5	0.56	0.57	0.54	0.58	1.47	0.58	0.54	0.6	0.5	0.49	0.53	0.56
B6	0.58	0.53	0.51	0.55	0.52	1.48	0.54	0.56	0.52	0.49	0.53	0.56
B7	0.55	0.51	0.51	0.56	0.53	0.54	1.44	0.57	0.51	0.46	0.5	0.53
B8	0.51	0.48	0.45	0.49	0.47	0.49	0.44	1.43	0.43	0.4	0.45	0.46
B9	0.54	0.48	0.48	0.51	0.48	0.52	0.48	0.53	1.4	0.43	0.48	0.5
B10	0.41	0.39	0.36	0.41	0.38	0.41	0.39	0.41	0.35	1.29	0.37	0.39
B11	0.55	0.51	0.51	0.54	0.5	0.52	0.48	0.52	0.48	0.45	1.42	0.52
B12	0.51	0.49	0.47	0.52	0.47	0.51	0.47	0.53	0.44	0.41	0.45	1.44

Step 3: Total relationship matrix from the normalised matrix, the total relationship matrix was calculated with the assistance and the total relationship matrix ‘‘M” is shown in Table 7.

Table 7. Total Relationship matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0.48	0.55	0.53	0.55	0.52	0.55	0.5	0.56	0.5	0.45	0.52	0.54
B2	0.62	0.5	0.58	0.61	0.58	0.6	0.55	0.62	0.56	0.52	0.56	0.58
B3	0.51	0.48	0.4	0.51	0.47	0.52	0.47	0.5	0.45	0.44	0.45	0.48
B4	0.55	0.53	0.48	0.46	0.51	0.55	0.49	0.55	0.48	0.46	0.47	0.5
B5	0.56	0.57	0.54	0.58	0.47	0.58	0.54	0.6	0.5	0.49	0.53	0.56
B6	0.58	0.53	0.51	0.55	0.52	0.48	0.54	0.56	0.52	0.49	0.53	0.56
B7	0.55	0.51	0.51	0.56	0.53	0.54	0.44	0.57	0.51	0.46	0.5	0.53
B8	0.51	0.48	0.45	0.49	0.47	0.49	0.44	0.43	0.43	0.4	0.45	0.46
B9	0.54	0.48	0.48	0.51	0.48	0.52	0.48	0.53	0.4	0.43	0.48	0.5
B10	0.41	0.39	0.36	0.41	0.38	0.41	0.39	0.41	0.35	0.29	0.37	0.39
B11	0.55	0.51	0.51	0.54	0.5	0.52	0.48	0.52	0.48	0.45	0.42	0.52
B12	0.51	0.49	0.47	0.52	0.47	0.51	0.47	0.53	0.44	0.41	0.45	0.44

Step 4: Sum of Rows ‘‘Ri” and Columns ‘‘Ci”. The total relationships received and given by each sub-category of barriers were calculated through Eqs. (5) and (6) are shown in Table 8. The total relationship matrix over sub-categories was calculated (with the same procedures as mentioned earlier)

Table 8. Sum of influences given and received on criteria

	R_i	C_i	$(R_i + C_i)$	$(R_i - C_i)$	
B1	6.25	6.36	12.6	-0.12	Effect
B2	6.89	6.03	12.9	0.86	Cause
B3	5.69	5.81	11.5	-0.12	Effect
B4	6.03	6.29	12.3	-0.26	Effect
B5	6.52	5.9	12.4	0.62	Cause
B6	6.36	6.29	12.7	0.07	Cause
B7	6.22	5.79	12	0.43	Cause
B8	5.49	6.39	11.9	-0.9	Effect

B9	5.85	5.64	11.5	0.22	Cause
B10	4.55	5.29	9.84	-0.75	Effect
B11	6	5.73	11.7	0.28	Cause
B12	5.7	6.03	11.7	-0.33	Effect

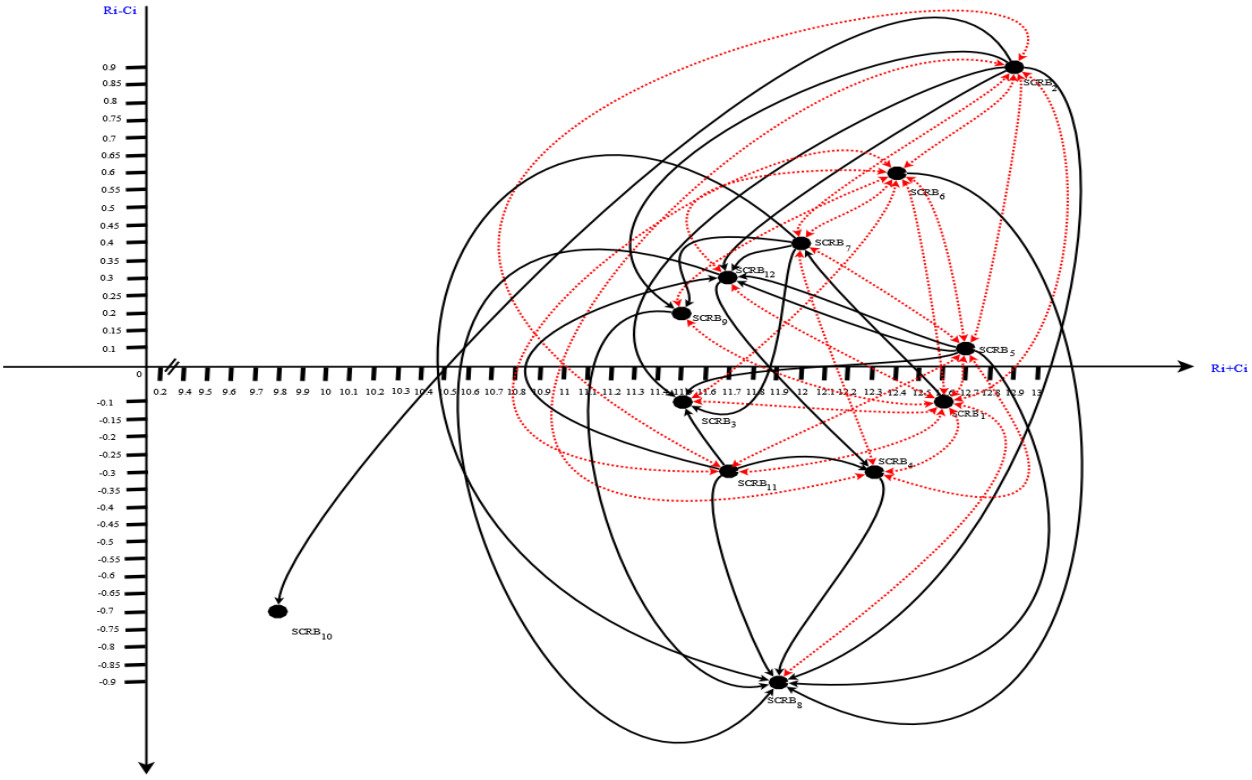

Figure 1. Diagraph

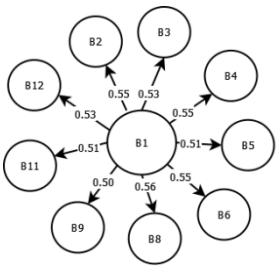

Figure 2 B1

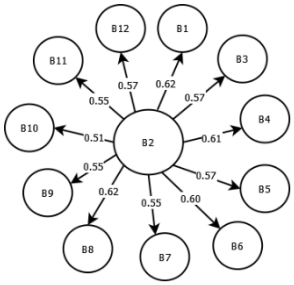

Figure 3 B2

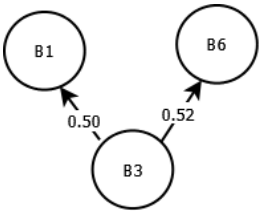

Figure 4 B3

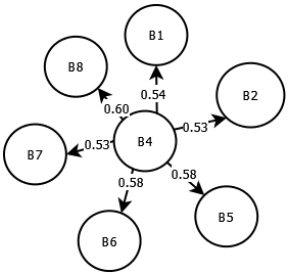

Figure 5 B4

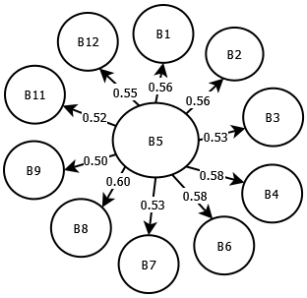

Figure 6 B5

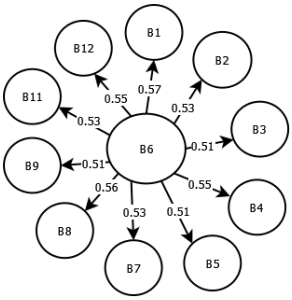

Figure 7 B6

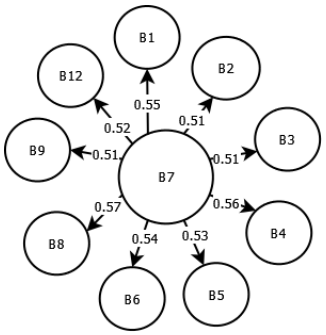

Figure 8 B7

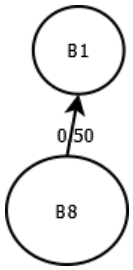

Figure 9 B8

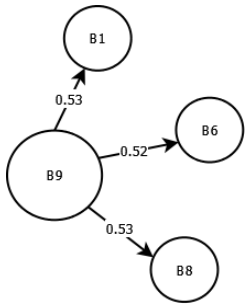

Figure 10 B9

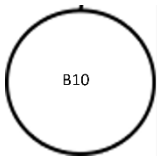

Figure 11 B10

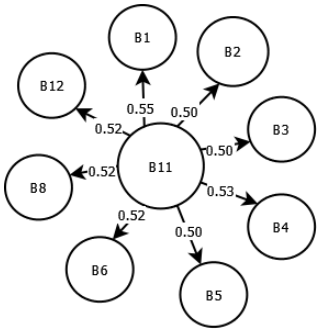

Figure 12 B11

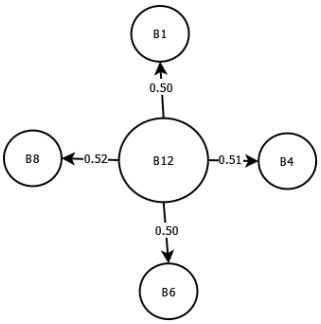

Figure 13 B12

7. Discussions

The DEMATEL analysis offers an integrated view of the interdependencies among the twelve critical barriers (B1–B12) that hinder SCR in Indian MSMEs. The cause–and–effect relationship was determined using prominence ($R_i + C_i$) and relation ($R_i - C_i$) values. Barriers with positive ($R_i - C_i$) values were categorised as causal barriers, implying a strong influence over others, while those with negative ($R_i - C_i$) values were identified as effect barriers, signifying that other factors more influence them. The results indicate that five barriers—B2, B5, B6, B7, B9, and B11—belong to the cause group, while B1, B3, B4, B8, B10, and B12 fall under the effect group. Among all barriers, B2 (Lack of Management Support) recorded the highest relation value ($R_i - C_i = 0.86$), establishing it as the most dominant causal factor influencing other barriers. This suggests that inadequate top-level commitment and the absence of leadership direction create ripple effects across operational, digital, and collaborative dimensions. B5 (Lack of Collaboration among Supply Chain Partners) and B7 (Resistance to Change) also emerged as key drivers, emphasising the behavioural and relational aspects of MSME resilience. Conversely, B8 (Supplier Dependency) and B10 (Lack of Government Regulation) lie deep within the effect cluster, indicating that these barriers are the outcomes of the systemic inefficiencies and managerial shortcomings prevalent within MSMEs.

The overall causal diagram (Figure 1) illustrates the intricate interrelationships among the 12 barriers that affect MSME SCR. Barriers such as B2, B5, B6, B7, B9, and B11 form the cause group, significant influence over the system, while B1, B3, B4, B8, B10, and B12 constitute the effect group, indicating high dependence. Among them, B2 stands as the most dominant causal barrier, driving managerial and operational challenges across the network. The directional chains, particularly B2 → B5 → B6 → B7 and B11 → B1 → B8, emphasise how weak leadership, poor collaboration, and limited risk planning collectively aggravate dependency and misalignment issues. Overall, the diagram highlights that strengthening managerial commitment, collaborative linkages, and workforce capabilities is essential for enabling MSMEs to move from reactive problem-solving toward proactive and adaptive SCR.

B1 –This barrier functions as a dependent node in Figure 2, influenced by B2, B5, and B11. Limited funding restricts technology adoption, skilled labour development, and collaborative projects. The influence arrows from B2 and B5 emphasise that managerial neglect and poor collaboration aggravate financial instability.

B2 As the strongest causal barrier, B2 Figure 3 exerts influence over almost all other barriers (B1, B3–B8, B11, B12). Its high prominence $R_i + C_i = 12.9$) signifies its strategic importance. Without leadership direction, MSMEs fail to integrate resilience strategies such as redundancy planning, digital monitoring, and cross-functional alignment.

B3 is positioned in the effect group; B3 is heavily influenced by B2 and B6 Figure 4 represent the influence. Poor investment in digital systems stems from managerial indifference and workforce skill gaps. This limits visibility across the supply chain, thereby increasing vulnerability during disruptions.

B4 is slightly influenced by others; B4 also transmits moderate effects toward B5 and B6, Figure 5 showing its bridging role. The bidirectional flow suggests that weak collaboration both causes and results from managerial inefficiency and poor communication channels.

B5 is one of the core causal drivers; B5 influences multiple barriers (B4, B6, B7, B8) which has been represented in Figure 6. Collaboration enhances knowledge exchange and supplier coordination, and its absence leads to fragmented responses during crises.

B6 is a moderately causal barrier; B6 links managerial and operational challenges. Figure 7 shows the influences of B7 and B9, implying that workforce capability gaps inhibit adaptive and innovative responses.

B7 has a positive (R_i - C_i) (0.43); B7 Figure 8 represents the behavioural pattern in MSMEs. It affects B4 and B6, demonstrating how reluctance toward new technologies and processes slows digital transformation and learning.

B8 has an effect barrier with strong dependence shown in Figure 9 (R_i - C_i = –0.90). B8 is the outcome of limited partnerships and risk planning. It is highly influenced by B1 and B9, implying that financial scarcity and limited supplier networks reinforce dependency on a few sources.

B9 is mildly causal, shown in Figure 10 (R_i - C_i = 0.22). B9 influences B6 and B8, suggesting that policy ambiguity and insufficient institutional support hinder MSMEs from upskilling and diversifying their supplier base.

B10 is placed firmly within the effect cluster shown in Figure 11. B10 exhibits low prominence $R_i + C_i = 9.84$) and negative influence (R_i - C_i = –0.75). It reflects the socio-cultural rigidity in MSMEs that affects open communication and the adoption of collaborative frameworks.

B11 is a notable causal barrier. Figure 12 shows how it is influencing B1, B6, and B12; B11 signifies the absence of proactive risk identification mechanisms. MSMEs often rely on reactive strategies, making them susceptible to cascading effects from minor disruptions.

B12 is the last in the effect group; B12 depends heavily on B4 and B11 shown in Figure 13, that misaligned goals and poor information exchange across partners stem from limited risk awareness and collaboration.

7.1 Implications

Managerial Implications

Managers should prioritize low-cost, high-impact actions such as strengthening supplier relationships, adopting simple digital tools, and engaging in cooperative risk-sharing with other MSMEs (BCG, 2025). Addressing financial barriers requires creative solutions, including leveraging government schemes and phased technology adoption (McKinsey, 2023). The analysis identifies lack of management support, collaboration, workforce skills, and risk awareness as the most influential causal barriers; thus, leadership commitment is central to driving systemic change. MSME leaders must embed resilience into strategy, performance metrics, and culture, while fostering open communication, trust-based partnerships, and continuous employee upskilling. Finally, resilience should be institutionalised through structured risk assessments and early warning systems, ensuring MSMEs transition from reactive responses to proactive preparedness, thereby enhancing agility, recovery speed, and long-term competitiveness.

8. Conclusion

This research establishes that resilient supply chains are a strategic necessity for the sustainability and competitiveness of MSMEs. Resource shortages, increased vulnerability to external shocks, and excessive reliance on complex supplier and market environments create uncertainties for MSMEs than the larger firms. These persistent challenges create interconnected barriers across the entire enterprise ecosystem, causing operational disruptions for the MSME ecosystem. In MSMEs, resilient supply chains extend beyond business

continuity to form the foundation for economic stability and sustainable growth. Since MSMEs are creating the economic engine for society through contributing GDP, exports, and employment, the economic necessity of the collective capability to withstand and recover from disturbances is profound. Ultimately, resilience in MSME supply chains represents a change in thinking from reactive survival strategies to proactive capability building that develops strong adaptive networks for greater competitiveness in industry while promoting inclusive socio-economic development.

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