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Analysis of Factors Influencing China's Cross-Border E-Commerce Supply Chain Resilience Based on the Fuzzy DEMATEL Model

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Abstract

Cross-Border E-Commerce (CBEC) plays an important role in China's economic expansion by streamlining global trade integration. The CBEC supply chains exhibit significant vulnerability to disruptions owing to their engagement with fragmented international markets, diverse stakeholder interests, and complex regulatory frameworks spanning multiple jurisdictions. A resilient supply chain not only withstands and recovers from unexpected disruptions but also ensures the uninterrupted flow of goods while sustaining customer demand satisfaction. However, many influencing factors prevent the implementation of resilient supply chain plans in CBEC. Identifying these factors is essential because it represents the foundational step toward developing actionable solutions. This study analyzes that the factors influencing the resilience of China's CBEC supply chains using the Fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL) model. In progress, a structured questionnaire was employed to gather primary data. Circulated in April and May 2024, the survey targeted experts well - versed in supply chain management. Findings reveal that cross-border logistics, information sharing, government support, agility in the supply chain, risk management culture and geographic distribution as cause factors, while inventory management, payment and credit system, visibility in the supply chain, and trust with partners are considered effect factors. The results provide actionable insights for policymakers and managers to enhance supply chain resilience in China's rapidly growing cross-border e-commerce sector.

Keywords: Cross-border E-Commerce, Supply chain resilience, Fuzzy DEMATEL, Affecting factors

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1.INTRODUCTION

Cross-Border E-Commerce (CBEC), as an important carrier of global trade in the era of digital economy, has become a new engine for China's foreign trade transformation and upgrading and economic growth. According to 2023 Annual Report on China's CBEC Market Data, China's CBEC transaction volume will account for 40.35% of the total import and export value of China's trade in goods of 41.76 trillion CNY in 2023 (WangJingShe, 2023). This significant ratio not only highlights the escalating importance of CBEC in China's economic structure but also attests to its transformative role in reshaping the dynamics of international trade.

However, with the accelerated evolution of global supply chain dynamics has presented increasingly intricate challenges to the development of CBEC. For example, frequent occurrences of geopolitical conflicts (e.g., Sino-U.S. trade friction, the Russia-Ukraine war), and disruptions in international logistics networks (e.g., port congestion, freight rate volatility), which not only causes direct financial losses for enterprises but also lead to operational inefficiencies (Yuan et al., 2024), severely undermining the international competitiveness of CBEC enterprises.

Based on the above, enhancing supply chain resilience (SCR) has been recognized as a critical strategy to address uncertainties (AlNuaimi et al., 2021; Raoufi & Fayek, 2021; Um & Han, 2021). SCR by strengthening risk resistance, adaptability, and recovery capabilities, can effectively mitigate the negative impacts of disruption events (Suryawanshi & Dutta, 2022). However, the implementation of SCR initiatives is impeded by various intertwined factors. These factors range from internal operational aspects, such as information sharing, inventory management, and agile response mechanisms, to external environmental factors, including geopolitical uncertainties, cultural differences, and regulatory complexities. Discovering these influencing factors is critically imperative, for it functions as the essential stepping towards the development of robust and effective countermeasures (Znagui, 2024).

Hence, this study aims to identify and analyze the influencing factors of CBEC supply chain resilience. There are two steps. First, identify the influencing factors through literature review and expert interviews. Second, Fuzzy Decision-Making Experimentation and Evaluation Laboratory (DEMATEL) is applied to assess the cause-effect relationships among these factors.

By applying the Fuzzy DEMATEL model to examine causal dynamics in China's CBEC supply chains, this research establishes a transferable framework for assessing interdependencies in complex global trade networks, while delivering empirically grounded strategies for policymakers and managers to bolster systemic resilience amid the sector's accelerated expansion.

The remainder of this paper is structured as follows: Section 2 reviews the relevant literature on the influencing factors of CBEC supply chain resilience and Fuzzy DEMATEL application. Section 3 details the methodology. Section 4 presents the results of the data analysis, and Section 5 concludes the study.

2. LITERATURE REVIEW

2.1 The influencing factors of CBEC supply chain resilience

Owing to its transnational essence, CBEC operates within supply chain networks that are inherently more complex than those of domestic e-commerce, characterized by dynamic regulatory landscapes, diverse market expectations, and heightened exposure to external risks. As such, the survival and development of CBEC enterprises are highly contingent upon "resilience" — specifically, the capacity to withstand shocks, rapidly recover from disruptions, and flexibly adapt to uncertainties in an ever - changing global business landscape (Liu et al., 2021). Considering the crucial and indispensable role that resilience plays in the operations of CBEC enterprises, a comprehensive investigation into the multifarious factors exerting influence on supply chain resilience is an imperative undertaking.

Existing literature has explored multiple influencing factors. For example, cross - border logistics is a linchpin in CBEC supply chains, yet its inherent complexity and vulnerability pose significant risks to resilience (Liu et al., 2021). Visibility allows supply chain managers to monitor the entire operation of the supply chain in real-time (Ivanov, 2021). This means that potential problems, such as production interruptions, logistics delays, or inventory shortages, can be identified promptly (Jain et al., 2017). Pettit et al. (2010) said that it provides managers with the opportunity to make quick responses when facing risks. Information sharing involves the real-time exchange of crucial data related to potential threats to avoid potential interruptions and their impacts. Effective information sharing among supply chain partners is fundamental for resilience (Meyer et al., 2021). Ali et al. (2017) stated that employee training and development are essential for cultivating employees' skills. In addition, de Sousa Jabbour et al. (2020) said that achieving resilience against pandemics such as COVID-19, it is essential to adopt a culture of risk management. In addition, government policies and the legal environment have become critical driving forces (Das et al., 2022). This is because government support and regulatory frameworks can provide stability and confidence to organizations, encouraging them to actively engage in innovative activities.

In conclusion, enhancing the resilience of CBEC supply chains requires a systematic integration of multiple factors, including logistics optimization, information transparency, human resource cultivation, risk management culture, and policy support, to cope with the dynamic and complex external environment.

2.2 Fuzzy DEMATEL Application

After identifying the influencing factors of CBEC supply chain resilience, it is essential to analyze the relationships and relative importance among these factors (Zhang et al., 2020), as it reveals the effective strategies to enhance risk prevention and control capabilities and optimize the overall supply chain performance.

The Fuzzy DEMATEL method is selected as the analytical tool due to its effectiveness in handling complex, uncertain, and subjective data (Alqahtani et al., 2023). This approach combines fuzzy logic with matrix-based analysis to address uncertainties in expert judgments, making it suitable for modeling complex systems like supply chains. Existing research indicates that the Fuzzy DEMATEL method has a wide range of applications across diverse fields, such as safety programs in regenerating abandoned industrial buildings, and construction industry and so on, as shown in Table 1.

Table 1 The Applications for Fuzzy DEMATEL

Authors	**Research purposes**
Abadi et al. (2021)	Determining effective criteria for resilient supplier selection.
Liu et al. (2021)	Identify of influencing factors in the CBEC supply chain resilience.
Zameni et al. (2021)	Evaluate the causal relationships of shift work, job stress, job satisfaction with the occupational health level in a petrochemical industry.
Abdullah et al. (2022)	Exploring key decisive factors in manufacturing strategies in the adoption of Industry 4.0
Chai et al. (2022)	Identify of critical success factors for safety program implementation of regeneration of abandoned industrial building projects in China.
Sharma et al. (2022)	Identify and segregate the supply chain vulnerability factors for manufacturing enterprises based on causal–effect relationships that exist between them.
Hossain et al. (2023)	Identify and priority the factors of green lean supply chain management.
Pandey and Mishra (2023)	Identify the key factors leading to truck mining accidents and the relationships among these factors.
Patel et al. (2024)	Assessing barriers of automation and robotics adoption in the Indian construction industry.
Xu et al. (2024)	Identify the key factors influencing scientific data sharing

In supply chain research, Fuzzy DEMATEL has proven particularly valuable. For example, Liu et al. (2021) used the method to identify influencing factors in CBEC supply chain resilience. Dolatabad et al. (2022) analyzed the key performance indicators of circular supply chains with Fuzzy DEMATEL, recognizing inventory availability, information availability, innovation, and technology as the key influential indicators. Sarker et al. (2023) categorized 15 supply chain resilience drivers into cause-and-effect groups and produced a priority list, identifying system robustness, geographically dispersed multiple suppliers, and risk management culture as the top three critical SCR drivers.

Figure 1 illustrates the steps of Fuzzy DEMATEL adopted in this study. The process begins with identifying the factors which are the key criteria relevant to the problem at hand. These factors, denoted as $f_1, f_2, ..., f_n$, where n is the number of factors. The experts on the direct influence of each factor f_i on every other factor f_j using linguistic terms such as 0 to 4 (0 = "no influence"; 1 = "little influence"; 2 = "medium influence"; 3 = "strong influence"; and 4 = "very strong influence") and convert these linguistic terms into triangular fuzzy numbers (TFNs), as shown in table 2.

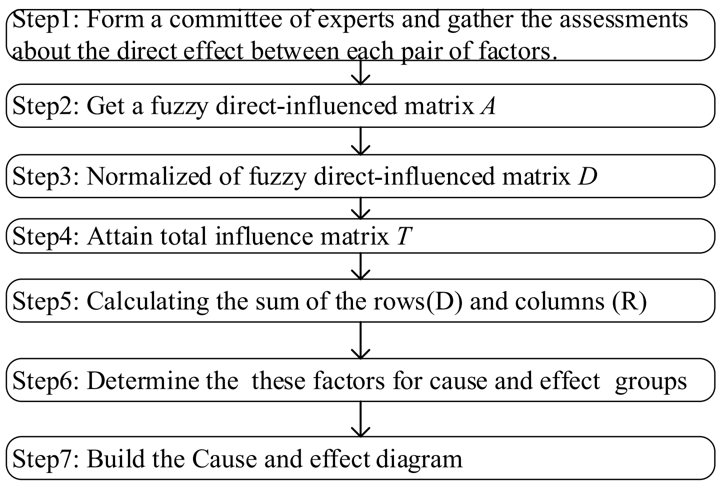

Figure 1 The Steps of Fuzzy DEMATEL

Table 1 Transformation of Linguistic Variables and Triangular Fuzzy Numbers

Linguistic variables	Influence score	Triangular fuzzy number
No influence (NO)	0	(0.00,0.00,0.25)
Very low influence (VL)	1	(0.00,0.25,0,50)
Little influence (L)	2	(0.25,0,50,0.75)
High influence (H)	3	(0.25,0,75,1.00)
Very high influence (VH)	4	(0,75,1.00,1.00)

Each expert then provides an $n \times n$ fuzzy direct relation matrixes $\tilde{A}^{(t)} = [\tilde{A}_{ij}^{(t)}]$, $\tilde{x}_{ij}^{(t)}$ is typically expressed as a TFNs $\tilde{A}_{ij}^{(t)} = (l_{ij}^{(t)}, m_{ij}^{(t)}, u_{ij}^{(t)})$, where l_{ij} denotes the lower bound, representing the minimum possible m_{ij} stands for the middle value, indicating the most likely influence u_{ij} refers to the upper bound, signifying the maximum possible influence. The aggregated fuzzy matrix A is then defuzzified into a crisp direct relation matrix D to enable mathematical operations. The total-relation matrix T, capturing both direct and indirect influences, is computed using $T = D(I-D)^{-1}$, where I am the identity matrix, $(I-D)^{-1}$ is its inverse. And then, determining the sum of rows and columns from the total-relation matrix T provides crucial insights into the influence dynamics within the system. The sum of the elements in row D_i and columns R_j represents the total influence that factor *i* has on all other factors in the system and the total influence that factor *j* receives from all other factors in the system (Gabus & Fontela, 1972).

Prominence ($D_{i+}R_j$), and relation (D_i - R_i) are two elements in Fuzzy DEMATEL method. Determining prominence of each factor is obtained by the sum of its row and column sums ($D_{i+}R_j$), which this value represents the overall importance of the factor within the system. If the prominence value is higher than that of other factors, it indicates that the factor is more significant in the system's overall dynamics. What's more, determining the relation D_i - R_i. If the value of $D_i - R_j > 0$, indicates that the factor is cause factor, oppositely, if the value of $D_i - R_j < 0$, indicates that the factor is effect factor. Finally, plot factors on a cause-effect relationship diagram with prominence on the x-axis and relation value on the y-axis.

3.METHODOLOGY

To achieve the study's objective, the flow of the methodology is shown in Figure 2.

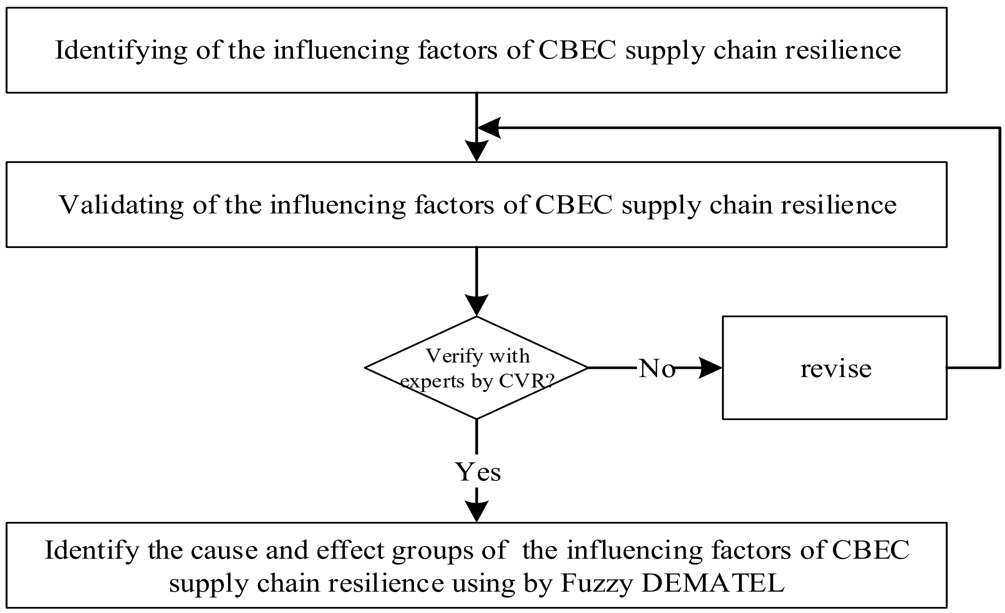

Figure 2 The Flow of Methodology

The literature review first focused on identifying the factors influencing that CBEC supply chain resilience. This identification process was conducted through a comprehensive examination of academic and industry publications. The initial list of the influencing factors was then subjected to expert validation to ensure relevance and practical significance. The expert profiles are detailed in Table 3. To assess content validity, Lawshe's method was employed, with the minimum threshold for the Content Validity Ratio (CVR) set at 0.99 (Gilbert & Prion, 2016). Factors with a CVR equal to or exceeding the benchmark were retained, the study proceeded to the next phase, while those falling below the threshold were excluded from further consideration. Upon final agreement on the validated set of factors, the Fuzzy DEMATEL was applied to explore the causal relationships among these factors.

Table 3 The details of Panel Members

Experts	Years of work experience	Educational level	Academic position	The nationalities and affiliations	Relevance to the CBEC context
1	25 years or more	Ph.D	Professor	China, University	Market Research and Consumer Behavior, Logistics and Supply Chain
2	10-15years	Ph.D	Associate professor	China, University	Logistics and Supply Chain, Data Analysis
3	3- 5-years	Ph.D	Lecturer	China, University	Logistics and Supply Chain
4	10-15years	M.S	Associate professor	China, University	Logistics and Supply Chain, Data Analysis
5	10-15years	M.S	Lecturer	China, University	Logistics and Supply Chain, Data Analysis

4.RESULTS AND DISCUSSION

4.1 The Identification of Influencing Factors for CBEC Supply Chain Resilience

The literature review identified 16 primary factors influencing CBEC supply chain resilience. These factors are concisely summarized in Table 4, with each factor outlined clearly.

Table 4 The Identification of 16 Influencing Factors for CBEC Supply Chain Resilience

No.	Influencing Factors	Definition	Sources
1	agility in supply chain	Management of the movement and coordination of goods across international borders, ensuring efficient and compliant operations.	(Yadav & Samuel, 2022); (Chen & Huang, 2022); (Sarker et al., 2023)
2	information sharing	The exchange of data and insights among supply chain partners to enhance transparency and decision-making.	(Qureshi et al., 2023); (Zhang et al., 2023); (Sunmola et al., 2023)
3	inventory management	Control of inventory levels, ordering, and usage to meet customer demand efficiently.	(Yazdanparast et al., 2021); (Priyadarshini et al., 2022); (Zhang et al., 2023)
4	customer demand variability	Fluctuations in customer purchasing behavior, affecting supply chain planning and inventory needs.	(Giuffrida et al., 2017); (Zhang et al., 2023)
5	visibility in supply chain	The ability to monitor goods and information across the supply chain in real-time for better responsiveness and risk reduction.	(Qureshi et al., 2023); (Zhang et al., 2023); (Sarker et al., 2023)
6	cross border logistics	The capacity of the supply chain to quickly adapt to unexpected changes or disruptions.	(Stoerk et al., 2019); (Giuffrida et al., 2020); (Lu et al., 2023);
7	government support	Assistance provided by governmental entities, such as subsidies, policy support, or infrastructure development.	(Singh et al., 2019); (Liu et al., 2021)

Table 4 (Continue)

No.	Influencing Factors	Definition	Sources
8	pay and credit system	Financial mechanisms that support transactions between supply chain partners, including credit terms and payment systems.	(Dahbi & Benmoussa, 2019); (Kofi Mensah & Simon Mwakapesa, 2021); (Lu et al., 2023);
9	trust with partner	The level of confidence and reliability established between supply chain partners, promoting cooperation and risk reduction.	(Thitimajshima et al., 2018); (Guo et al., 2018); (Al Naimi et al., 2022)
10	geographic distribution	The spatial placement of supply chain facilities and partners, influencing efficiency, costs, and responsiveness.	(Chen & Huang, 2022); (Sarker et al., 2023); (Wang et al., 2023)
11	risk management culture	It systematically internalized values, behavioral norms, and institutional frameworks within an organization, enacted through a tri-level mechanism of leadership commitment, employee engagement, and cross-functional collaboration.	(Yazdanparast et al., 2021); (Liu et al., 2021); (Al Naimi et al., 2022)
12	cross border logistics infrastructure	Physical and technological facilities (e.g., warehouses, transportation networks, IT systems) support cross-border logistics.	(Lu & Wang, 2016); (Sassi, 2023);
13	artificial intelligence	Use of machine learning and data analytics to automate processes, optimize decision-making, and predict patterns in the supply chain.	(Zouari et al., 2021); (Al Naimi et al., 2022); (Tang et al., 2023)
14	customs clearance	The official procedures for moving goods through customs to comply with regulatory requirements for import/export.	(Liu et al., 2021); (Zhou et al., 2022)
15	cybersecurity measures	Security practices to protect digital information and systems within the supply chain from cyber threats.	(Alwan et al., 2023); (Luo & Choi, 2022)
16	staff training and development	Programs aimed at improving employee skills and knowledge to enhance efficiency and adaptability in supply chain operations.	(Bevilacqua et al., 2020); (Qureshi et al., 2022); (Das et al., 2022)

4.2 Validated Influencing Factors

Based on the Content Validity Ratio (CVR) results in Table 5, it was evidenced that 10 out of the 16 initially identified factors have a CVR of 1.0, indicating strong content validity and significant influence on CBEC supply chain resilience. These factors included agility in the supply chain, information sharing, inventory management, visibility in supply chain, cross border logistics, government support, pay and credit system, trust with partners, geographic distribution, risk management culture. Conversely, factors such as customer demand variability, cross-border logistics infrastructure, artificial intelligence, customs clearance, cybersecurity measures, staff training and development exhibit did not exceed the benchmark of CVR values. This suggests that these factors may not be as directly impactful as initially hypothesized, or there might be a lack of consensus among the experts surveyed regarding their influence on supply chain resilience.

Table 5 The Result of Influencing Factors Based on CVR

Influencing Factors	Code	CVR	Valid? (≥0.99)
agility in supply chain	IF 1	1.0	Yes
information sharing	IF 2	1.0	Yes
inventory management	IF 3	1.0	Yes
government support	IF 4	1.0	Yes
cross border logistics	IF 5	1.0	Yes
visibility in supply chain	IF 6	1.0	Yes
pay and credit system	IF 7	1.0	Yes
trust with partner	IF 8	1.0	Yes
geographic distribution	IF 9	1.0	Yes
risk management culture	IF 10	1.0	Yes
customer demand variability		0.6	No
cross border logistics infrastructure		0.6	No
artificial intelligence		0.6	No
customs clearance		0.6	No
cybersecurity measures		0.6	No
staff training and development		0.6	No

Table 6 The fuzzy direct-relation matrix (A)

a_{ij}	IF 1	IF 2	IF 3	IF 4	IF 5	IF 6	IF 7	IF 8	IF 9	IF 10
IF 1	0.000	0.640	0.733	0.780	0.733	0.733	0.780	0.733	0.593	0.593
IF 2	0.780	0.000	0.780	0.780	0.733	0.640	0.780	0.733	0.593	0.593
IF 3	0.640	0.733	0.000	0.827	0.780	0.593	0.687	0.687	0.547	0.453
IF 4	0.640	0.687	0.780	0.000	0.920	0.873	0.920	0.920	0.687	0.640
IF 5	0.687	0.780	0.687	0.687	0.000	0.780	0.873	0.873	0.687	0.733
IF 6	0.687	0.687	0.687	0.593	0.687	0.000	0.733	0.733	0.640	0.687
IF 7	0.687	0.640	0.593	0.593	0.547	0.640	0.000	0.827	0.593	0.500
IF 8	0.733	0.640	0.687	0.687	0.687	0.687	0.733	0.000	0.500	0.500
IF 9	0.593	0.687	0.687	0.640	0.640	0.640	0.687	0.687	0.000	0.687
IF 10	0.640	0.640	0.687	0.687	0.547	0.640	0.593	0.687	0.687	0.000

Table 7 The normalized the fuzzy direct relation matrix (D)

a_{ij}	IF 1	IF 2	IF 3	IF 4	IF 5	IF 6	IF 7	IF 8	IF 9	IF 10
IF 1	0.000	0.091	0.104	0.110	0.104	0.104	0.110	0.104	0.084	0.084
IF 2	0.110	0.000	0.110	0.110	0.104	0.091	0.110	0.104	0.084	0.084
IF 3	0.091	0.104	0.000	0.117	0.110	0.084	0.097	0.097	0.077	0.064

Table 7 (Continue)

a_{ij}	IF 1	IF 2	IF 3	IF 4	IF 5	IF 6	IF 7	IF 8	IF 9	IF 10
IF 4	0.091	0.097	0.110	0.000	0.130	0.124	0.130	0.130	0.097	0.091
IF 5	0.097	0.110	0.097	0.097	0.000	0.110	0.124	0.124	0.097	0.104
IF 6	0.097	0.097	0.097	0.084	0.097	0.000	0.104	0.104	0.091	0.097
IF 7	0.097	0.091	0.084	0.084	0.077	0.091	0.000	0.117	0.084	0.071
IF 8	0.104	0.091	0.097	0.097	0.097	0.097	0.104	0.000	0.071	0.071
IF 9	0.084	0.097	0.097	0.091	0.091	0.091	0.097	0.097	0.000	0.097
IF 10	0.091	0.091	0.097	0.097	0.077	0.091	0.084	0.097	0.097	0.000

Table 8 The total relation matrix (T)

a_{ij}	IF 1	IF 2	IF 3	IF 4	IF 5	IF 6	IF 7	IF 8	IF 9	IF 10
IF 1	0.630	0.716	0.744	0.745	0.742	0.737	0.796	0.799	0.651	0.637
IF 2	0.739	0.642	0.758	0.755	0.751	0.735	0.806	0.809	0.659	0.644
IF 3	0.682	0.696	0.618	0.719	0.716	0.689	0.752	0.759	0.617	0.593
IF 4	0.779	0.788	0.817	0.713	0.830	0.820	0.885	0.895	0.722	0.701
IF 5	0.759	0.772	0.779	0.775	0.687	0.782	0.850	0.859	0.698	0.688
IF 6	0.700	0.702	0.719	0.704	0.716	0.623	0.769	0.777	0.639	0.631
IF 7	0.653	0.650	0.660	0.656	0.652	0.659	0.624	0.736	0.591	0.567
IF 8	0.682	0.674	0.695	0.691	0.693	0.688	0.744	0.658	0.601	0.588
IF 9	0.672	0.686	0.702	0.692	0.693	0.689	0.745	0.753	0.541	0.616
IF 10	0.665	0.668	0.689	0.685	0.670	0.676	0.720	0.739	0.618	0.517

Table9 The Cause-and-Effect Groups of Influencing Factors

Factors	Code	D	R	D+R	RANK	D-R	RANK	CAUSE OR EFFECT
agility in supply chain	IF 1	7.197	6.961	14.159	5	0.236	6	cause
information sharing	IF 2	7.297	6.993	14.290	4	0.304	5	cause
inventory management	IF 3	6.841	7.179	14.021	8	-0.338	8	effect
government support	IF 4	7.950	7.135	15.085	1	0.814	1	cause
cross border logistics	IF 5	7.649	7.151	14.799	2	0.498	2	cause
visibility in supply chain	IF 6	6.979	7.098	14.076	7	-0.119	7	effect
pay and credit system	IF 7	6.447	7.690	14.137	6	-1.243	10	effect
trust with partners	IF 8	6.715	7.785	14.499	3	-1.070	9	effect
geographic distribution	IF 9	6.789	6.337	13.127	9	0.452	4	cause
risk management culture	IF 10	6.649	6.183	12.832	10	0.466	3	cause

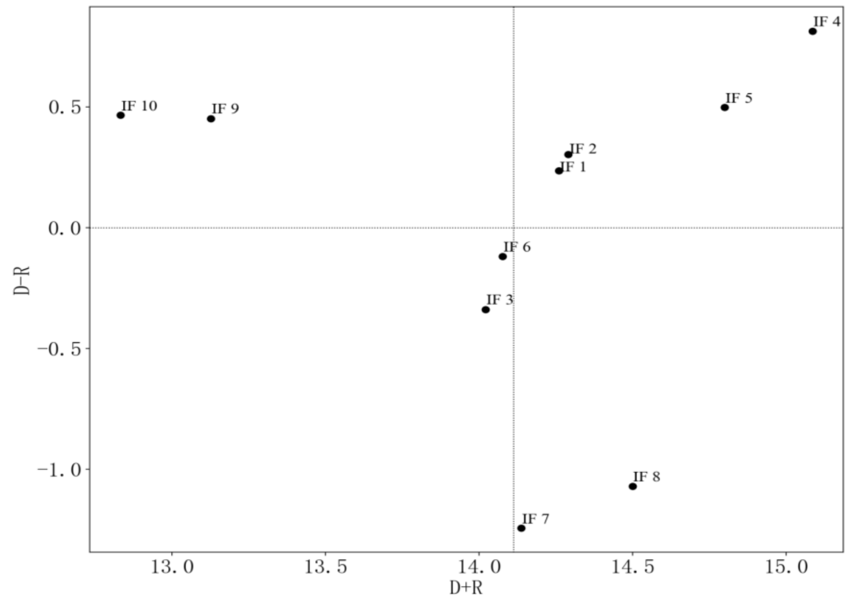

Figure 3 The Cause-and-Effect Diagram

In general, the parameters (D + R) and (D - R) are commonly used to evaluate both the overall prominence of each factor within the system and its role as either a cause or an effect in the network of interdependencies. (Jindal et al., 2021; Xia et al., 2015).

As shown in Table 9, the importance ratings of the influencing factors of CBEC supply chain resilience are based on the (D + R) values and noticed that factor IF 4 (government support) have a greater importance rating than other factors. The prioritized sequence of resilience determinants in CBEC supply chains, ranked by descending ($D_i + R_j$) scores, unfolds as: IF4 > IF5 > IF8 > IF2 > IF1 > IF7 > IF6 > IF3 > IF9 > IF10.

According to Table 9 and Figure 3, the influencing factors of CBEC supply chain resilience are clearly divided into cause-and-effect groups based on the D-R values derived from the Fuzzy DEMATEL analysis. Specifically, six factors–government support (IF4), cross-border logistics (IF5), risk management culture (IF10), geographic distribution (IF9), information sharing (IF2), and supply chain agility (IF1)–exhibit positive D-R values and are therefore classified as cause factors. These elements exert a strong influence on other variables in the system and can be considered strategic leverage points for enhancing overall resilience. Among them, government support (IF4) ranks first with an D-R value of 0.814, and its D+R value (7.950) also tops the list, which means it has the strongest influence on other factors. Cross-border logistics (IF5) has an D-R value of 0.498 and a relatively high D value (7.649), indicating that it has a significant driving effect on the supply chain. Conversely, four factors–trust with partners (IF8), pay and credit system (IF7), inventory management (IF3), and visibility in the supply chain (IF6)–have negative R-C values and are categorized as effect factors, suggesting they are more likely to be outcomes of improvements in the causal group. For instance, trust and visibility are dependent on the effectiveness of information sharing and institutional support, while inventory management and payment reliability benefit from improvements in logistics infrastructure and regulatory environments.

This paper holds significant value both theoretically and practically in the field of CBEC supply chain resilience. From a theoretical perspective, this study contributes to the resilience literature by integrating Fuzzy DEMATEL within the CBEC context, offering a structured way to model complex interdependencies among resilience factors. It also affirms the importance of institutional and infrastructural variables in shaping operational outcomes. From a practical standpoint, the findings serve as a decision-support tool for policymakers, logistics providers, and platform operators. By focusing resources on high-leverage causal factors, stakeholders can create more resilient and responsive CBEC systems capable of withstanding regulatory changes, geopolitical instability, and demand fluctuations.

5. CONCLUSION

This study aimed to analyse the influencing factors affecting CBEC supply chain resilience using by Fuzzy DEMATEL. Through an extensive review of academic literature from databases like Google Scholar and Scopus, 16 factors were initially identified. These were later refined to 10 factors through CVR evaluation. The Fuzzy DEMATEL was applied to assess cause-effect relationships among these factors. The findings indicated that factors such as cross-border logistics, information sharing, government support, agility in the supply chain, risk management culture and geographic distribution emerged as prominent cause factors. These elements act as foundational drivers, exerting significant direct and indirect impacts on other factors within the supply chain ecosystem. In contrast, inventory management, pay and credit system, visibility in the supply chain, and trust with partners were identified as effect factors, reflecting the operational outcomes of the resilience-building process.

It is important to note that this study is constrained by subjective expert cognitive biases and the static nature of its analytical model. Future research could incorporate dynamic Bayesian networks to explore the time-varying impacts of fluctuations in U.S.-China trade policies on causal structures.

REFERENCES

Abadi, S. K. G., Bathaei, A., Awang, S. R., & Ahmad, T. (2021). Suppliers selection in resilient supply chain by using fuzzy DEMATEL approach (case study in SAPCO supply chain). *Journal of Social, management and tourism letter*, *2021*(1), 1-17.

Abdullah, F. M., Al-Ahmari, A. M., & Anwar, S. (2022). Exploring key decisive factors in manufacturing strategies in the adoption of Industry 4.0 by using the fuzzy DEMATEL method. *Processes*, *10*(5), 987.

Al Naimi, M., Faisal, M. N., Sobh, R., & Bin Sabir, L. (2022). A systematic mapping review exploring 10 years of research on supply chain resilience and reconfiguration. *International Journal of Logistics Research and Applications*, *25*(8), 1191-1218.

Ali, I., Nagalingam, S., & Gurd, B. (2017). Building resilience in SMEs of perishable product supply chains: enablers, barriers and risks. *Production Planning & Control*, *28*(15), 1236-1250.

AlNuaimi, B. K., Singh, S. K., & Harney, B. (2021). Unpacking the role of innovation capability: Exploring the impact of leadership style on green procurement via a natural resource-based perspective. *Journal of Business Research*, *134*, 78-88.

Alqahtani, F. M., Noman, M. A., Alabdulkarim, S. A., Alharkan, I., Alhaag, M. H., & Alessa, F. M. (2023). A New Model for Determining Factors Affecting Human Errors in Manual Assembly Processes Using Fuzzy Delphi and DEMATEL Methods. *Symmetry*, *15*(11), 1967.

Alwan, S. Y., Hu, Y., Al Asbahi, A. A. M. H., Al Harazi, Y. K., & Al Harazi, A. K. (2023). Sustainable and resilient e-commerce under COVID-19 pandemic: a hybrid grey decision-making approach. *Environmental Science and Pollution Research*, *30*(16), 47328-47348.

Bevilacqua, M., Ciarapica, F. E., Marcucci, G., & Mazzuto, G. (2020). Fuzzy cognitive maps approach for analysing the domino effect of factors affecting supply chain resilience: a fashion industry case study. *International Journal of Production Research*, *58*(20), 6370-6398.

Chai, Q., Li, H., Tian, W., & Zhang, Y. (2022). Critical success factors for safety program implementation of regeneration of abandoned industrial building projects in China: A fuzzy DEMATEL approach. *Sustainability*, *14*(3), 1550.

Chen, J.-K., & Huang, T.-Y. (2022). The Multi-Level Hierarchical Structure of the Enablers for Supply Chain Resilience Using Cloud Model-DEMATEL–ISM Method. *Sustainability*, *14*(19), 12116.

Dahbi, S., & Benmoussa, C. (2019). What hinder SMEs from adopting E-commerce? A multiple case analysis. *Procedia computer science*, *158*, 811-818.

Das, D., Datta, A., Kumar, P., Kazancoglu, Y., & Ram, M. (2022). Building supply chain resilience in the era of COVID-19: An AHP-DEMATEL approach. *Operations Management Research*, *15*(1), 249-267.

de Sousa Jabbour, A. B. L., Jabbour, C. J. C., Hingley, M., Vilalta-Perdomo, E. L., Ramsden, G., & Twigg, D. (2020). Sustainability of supply chains in the wake of the coronavirus (COVID-19/SARS-CoV-2) pandemic: lessons and trends. *Modern supply chain research and applications*, *2*(3), 117-122.

Dolatabad, A. H., Mahdiraji, H. A., Babgohari, A. Z., Garza-Reyes, J. A., & Ai, A. (2022). Analyzing the key performance indicators of circular supply chains by hybrid fuzzy cognitive mapping and Fuzzy DEMATEL: evidence from healthcare sector. *Environment, Development and Sustainability*, 1-27.

Gabus, A., & Fontela, E. (1972). World problems, an invitation to further thought within the framework of DEMATEL. *Battelle Geneva Research Center, Geneva, Switzerland*, *1*(8), 12-14.

Gilbert, G. E., & Prion, S. (2016). Making sense of methods and measurement: Lawshe's content validity index. *Clinical simulation in nursing*, *12*(12), 530-531.

Giuffrida, M., Mangiaracina, R., Perego, A., & Tumino, A. (2017). Cross-border B2C e-commerce to Greater China and the role of logistics: a literature review. *International Journal of Physical Distribution & Logistics Management*, *47*(9), 772-795.

Giuffrida, M., Mangiaracina, R., Perego, A., & Tumino, A. (2020). Cross-border B2C e-commerce to China: an evaluation of different logistics solutions under uncertainty. *International Journal of Physical Distribution & Logistics Management*, *50*(3), 355-378.

Guo, Y., Bao, Y., Stuart, B. J., & Le‐Nguyen, K. (2018). To sell or not to sell: Exploring sellers' trust and risk of chargeback fraud in cross‐border electronic commerce. *Information Systems Journal*, *28*(2), 359-383.

Hossain, M. I., Al Amin, M., Baldacci, R., & Rahman, M. H. (2023). Identification and prioritization of green lean supply chain management factors using fuzzy DEMATEL. *Sustainability*, *15*(13), 10523.

Ivanov, D. (2021). Digital supply chain management and technology to enhance resilience by building and using end-to-end visibility during the COVID-19 pandemic. *IEEE Transactions on Engineering Management*.

Jain, V., Kumar, S., Soni, U., & Chandra, C. (2017). Supply chain resilience: model development and empirical analysis. *International Journal of Production Research*, *55*(22), 6779-6800.

Jindal, A., Sharma, S. K., Sangwan, K. S., & Gupta, G. (2021). Modelling supply chain agility antecedents using fuzzy DEMATEL. *Procedia CIRP*, *98*, 436-441.

Kofi Mensah, I., & Simon Mwakapesa, D. (2021). Cross-Border E-Commerce Diffusion and Usage During the period of the COVID-19 Pandemic: A literature Review. Proceedings of the 3rd Africa-Asia

Dialogue Network (AADN) International Conference on Advances in Business Management and Electronic Commerce Research,

Liu, X., Dou, Z., & Yang, W. (2021). Research on influencing factors of cross border E-commerce supply chain resilience based on integrated fuzzy DEMATEL-ISM. *IEEE Access*, *9*, 36140-36153.

Lu, B., & Wang, H. (2016). Research on the competitive strategy of cross-border e-commerce comprehensive pilot area based on the spatial competition. *Scientific Programming*, *2016*.

Lu, Y.-H., Yeh, C.-C., & Liau, T.-W. (2023). Exploring the key factors affecting the usage intention for cross-border e-commerce platforms based on DEMATEL and EDAS method. *Electronic Commerce Research*, *23*(4), 2517-2539.

Luo, S., & Choi, T. M. (2022). E‐commerce supply chains with considerations of cyber‐security: Should governments play a role? *Production and Operations Management*, *31*(5), 2107-2126.

Meyer, A., Niemann, W., Weerheim, C., Bekker, M., & Oosthuizen, H. (2021). The role of Information-Sharing on supply chain resilience: a study in the South African retail industry. *The Retail and Marketing Review*, *17*(2), 2-16.

Pandey, B. P., & Mishra, D. P. (2023). Developing an alternate mineral transportation system by evaluating risk of truck accidents in the mining industry—a critical fuzzy DEMATEL approach. *Sustainability*, *15*(8), 6409.

Patel, T., Bapat, H., & Patel, D. (2024). Assessing barriers of automation and robotics adoption in the Indian construction industry: a fuzzy DEMATEL approach. *Construction Innovation*.

Pettit, T. J., Fiksel, J., & Croxton, K. L. (2010). Ensuring supply chain resilience: development of a conceptual framework. *Journal of business logistics*, *31*(1), 1-21.

Priyadarshini, J., Singh, R. K., Mishra, R., & Bag, S. (2022). Investigating the interaction of factors for implementing additive manufacturing to build an antifragile supply chain: TISM-MICMAC approach. *Operations Management Research*, *15*(1-2), 567-588.

Qureshi, K. M., Mewada, B. G., Alghamdi, S. Y., Almakayeel, N., Qureshi, M. R. N., & Mansour, M. (2022). Accomplishing sustainability in manufacturing system for small and medium-sized enterprises (SMEs) through lean implementation. *Sustainability*, *14*(15), 9732.

Qureshi, K. M., Mewada, B. G., Buniya, M. K., & Qureshi, M. R. N. M. (2023). Analyzing Critical Success Factors of Lean 4.0 Implementation in Small and Medium Enterprises for Sustainable Manufacturing Supply Chain for Industry 4.0 Using PLS-SEM. *Sustainability*, *15*(6), 5528.

Raoufi, M., & Fayek, A. R. (2021). Identifying actions to control and mitigate the effects of the COVID-19 pandemic on construction organizations: Preliminary findings. *Public Works Management & Policy*, *26*(1), 47-55.

Sarker, M. R., Rahman, M. S., Ali, S. M., Hossain, N. U. I., & Gonzalez, E. D. S. (2023). Modeling supply chain resilience drivers in the context of COVID-19 in manufacturing industries: leveraging the advantages of approximate fuzzy DEMATEL. *Journal of Intelligent Manufacturing*, 1-20.

Sassi, A. (2023). A Systematic Literature Review of Factors to Improve Tanzania's Cross-Border E-Commerce Performance: Lessons from China. *East African Journal of Science, Technology and Innovation*, *4*.

Sharma, S. K., Routroy, S., Singh, R. K., & Nag, U. (2022). Analysis of supply chain vulnerability factors in manufacturing enterprises: a fuzzy DEMATEL approach. *International Journal of Logistics Research and Applications*, 1-28.

Singh, C. S., Soni, G., & Badhotiya, G. K. (2019). Performance indicators for supply chain resilience: review and conceptual framework. *Journal of Industrial Engineering International*, *15*, 105-117.

Stoerk, T., Dudek, D. J., & Yang, J. (2019). China's national carbon emissions trading scheme: Lessons from the pilot emission trading schemes, academic literature, and known policy details. *Climate Policy*, *19*(4), 472-486.

Sunmola, F., Burgess, P., Tan, A., Chanchaichujit, J., Balasubramania, S., & Mahmud, M. (2023). Prioritising Visibility Influencing Factors in Supply Chains for Resilience. *Procedia computer science*, *217*, 1589-1598.

Suryawanshi, P., & Dutta, P. (2022). Optimization models for supply chains under risk, uncertainty, and resilience: A state-of-the-art review and future research directions. *Transportation research part e: logistics and transportation review*, *157*, 102553.

Tang, Y. M., Chau, K. Y., Lau, Y.-y., & Zheng, Z. (2023). Data-intensive inventory forecasting with artificial intelligence models for cross-border e-commerce service automation. *Applied Sciences*, *13*(5), 3051.

Thitimajshima, W., Esichaikul, V., & Krairit, D. (2018). A framework to identify factors affecting the performance of third-party B2B e-marketplaces: A seller's perspective. *Electronic Markets*, *28*, 129-147.

Um, J., & Han, N. (2021). Understanding the relationships between global supply chain risk and supply chain resilience: the role of mitigating strategies. *Supply chain management: An international journal*, *26*(2), 240-255.

Wang, J., Yu, M., & Liu, M. (2023). Influencing factors on Green Supply Chain Resilience of Agricultural Products: An Improved Grey-DEMATEL-ISM Approach. *Frontiers in Sustainable Food Systems*, *7*, 1166395.

WangJingShe. (2023). *Zhongguo kuajing dianshang shichang shuju baogao [2023 China cross-border e-commerce market data report]. 100EC.cn.* https://www.100ec.cn/zt/2023kjdsscbg/

Xia, X., Govindan, K., & Zhu, Q. (2015). Analyzing internal barriers for automotive parts remanufacturers in China using grey-DEMATEL approach. *Journal of cleaner production*, *87*, 811-825.

Xu, Z., Liu, L., & Meng, Z. (2024). What are the key factors influencing scientific data sharing? A combined application of grounded theory and fuzzy-DEMATEL approach. *Heliyon*, *10*(15).

Yadav, A. K., & Samuel, C. (2022). Modeling the Barriers of the Resilient Supply Chain: A Fuzzy-Dematel Approach. *Journal of Advanced Manufacturing Systems*, *21*(04), 727-762.

Yazdanparast, R., Tavakkoli-Moghaddam, R., Heidari, R., & Aliabadi, L. (2021). A hybrid Z-number data envelopment analysis and neural network for assessment of supply chain resilience: a case study. *Central European journal of operations research*, *29*, 611-631.

Yuan, K., Zhang, C., Hou, R., & Gao, X. (2024). Can cross-border e-commerce development improve supply chain efficiency? Empirical evidence from China. *Applied Economics*, 1-17.

Zameni, F., Nasiri, P., Mahdinia, M., & Soltanzadeh, A. (2021). Analysis of the causal relationships of shift work, job stress and job satisfaction with the occupational health level based on fuzzy DEMATEL method: a cross sectional study. *Journal of Health and safety at Work*, *11*(1), 151-163.

Zhang, G., Zhou, S., Xia, X., Yüksel, S., Baş, H., & Dincer, H. (2020). Strategic mapping of youth unemployment with interval-valued intuitionistic hesitant fuzzy DEMATEL based on 2-tuple linguistic values. *IEEE Access*, *8*, 25706-25721.

Zhang, H., Jia, F., & You, J.-X. (2023). Striking a balance between supply chain resilience and supply chain vulnerability in the cross-border e-commerce supply chain. *International Journal of Logistics Research and Applications*, *26*(3), 320-344.

Zhou, L., Wang, J., Li, F., Xu, Y., Zhao, J., & Su, J. (2022). Risk aversion of B2C cross-border e-commerce supply chain. *Sustainability*, *14*(13), 8088.

Znagui, Z. (2024). Examining factors influencing the emergence of a knowledge society: an explorative study. *Journal of e-Learning and Knowledge Society*, *20*(2), 28-41.

Zouari, D., Ruel, S., & Viale, L. (2021). Does digitalising the supply chain contribute to its resilience? *International Journal of Physical Distribution & Logistics Management*, *51*(2), 149-180.