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The Effects of Globalization to Supply Chain Resilience: Outsourcing Techniques as Interventionism, Protectionism and Regionalization Strategies

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Abstract

Globalization may cause companies to broaden their customer bases, operate internationally, and serve more customers. However, it also entails dangers, including shifting circumstances, disruptions, and elevated prices. To address these issues, outsourcing has evolved, lowering outputs and service costs. To mitigate these risks, businesses employ strategies such as interventionism, protectionism, and regionalization. By investigating and simulating the interplay of outsourcing approaches to equip businesses with supply chain resilience (SCRES), this study aims to close the knowledge gap between the existing knowledge and global supply chain (GSC) risk management practices. To choose the best alternative for our case study

company, we analyzed four distinct outsourcing techniques, namely offshoring, reshoring, nearshoring, and farshoring; furthermore, we investigated the outsourcing elements typically taken into account to achieve resilience. The results indicated that the reshoring method would be the most promising one for this company, under specific circumstances, in terms of attaining resilience in the manufacturing industry.

Keywords: Global supply chains, Resilience, Outsourcing strategies, Reshoring, Regionalization, MCDM, Risk management.

1 Introduction

Globalization has allowed businesses to transcend geographical boundaries in terms of both offshore manufacturing and market coverage, implying that longer distances can be traversed, borders can be crossed, and a greater number of engaged actors as well as a larger, more diverse customer base can be satisfied (Colicchia et al. 2010). Owing to globalization, multinational corporations build production operations in low-cost foreign nations to offer intermediary components or finished products to their domestic retailing businesses; this is known as offshoring (Yang et al. 2021). Although globalization provides businesses with these benefits, it has negative impacts, such as increasing the susceptibility to natural catastrophes and increasing the complexity of the design of global supply chain (GSC) networks since multinational business settings must address these disruptions and risks (Aydin et al. 2014; Hasani and Khosrojerdi 2016). GSCs require highly coordinated movements of commodities, services, and information within and beyond national borders (Mentzer 2001; Um and Han 2020). Hence, supply chains (SCs), especially GSCs, are extremely complicated and constantly changing; furthermore, in many instances, they are internationally dispersed systems that are vulnerable to a wide range of hazards that jeopardize supplier performance and the SC's overall performance (Bundschuh et al. 2003).

GSCs are frequently impacted by uncontrollable accidents and interruptions (Corominas 2013; Elkins et al. 2005). While flexible and resilient techniques are essential for dealing with disruptions, many of these tactics have been deemed redundant by other management models, such as agile and lean manufacturing (Christopher and Lee 2008). To react to unanticipated economic shocks, it is critical to expand the sources of supply and establish new SCs that are more resilient, nimble, adaptable (Miceli et al. 2021; Settembre-Blundo et al. 2021), and sustainable while also attempting to minimize the SC carbon footprint (Fernández-Miguel et al.

2022; García Alcaraz et al. 2022). To successfully handle this ever-changing environment that is rife with challenges and disruptions—such as pandemics, wars, political disagreements, terrorism, economic crises, and climate change issues—that weaken and worsen GSCs, risk management has become critical; risk management is needed for a company to remain on the market, maintain competitiveness, and, most importantly, be resilient to disruptions and shocks.

As SCs are growing more vulnerable to unfavorable occurrences, there is a need to control these risks through the development of supply chain resilience (SCRES) (Colicchia et al. 2010). Resilience, which is considered one of the essential parts of GSCs, refers to a firm's ability to adapt to external threats, ambiguities, and interruptions (Sajjad 2021). The perceived capacity of some SCs to rebound more quickly from common possible risks than others has recently sparked a debate regarding SCRES (Jüttner and Maklan 2011). SCRES strives to build the adaptive skill to manage unforeseen occurrences; react to and rebound from interruptions (Ponomarov and Holcomb 2009); and manage risks.

Risk management within SCs is not a new issue; however, due to rising economic competitiveness and increased linkages across businesses and sectors, businesses are now more vulnerable to risk sources than ever before (Colicchia et al. 2010). Natural catastrophes, political disagreements, transportation problems, cyber-attacks, terrorism, power cuts, staff shortages, and human error are potential sources of disruption (Grossman et al. 2021) that require appropriate risk management. As a result of these interruptions, GSCs have been undergoing a transition during the last decade with the effect of some macro-level tendencies, such as protectionism, interventionist governmental policies, sustainability, and the deployment of digitalization in production; these indicate a tendency toward de-globalization (Pla-Barber et al. 2021; Petricevic and Teece 2019). To mitigate these risks, SCs must be built to include event readiness and enable an effective and efficient reaction, and it should be possible to restore them to their original form or a better one following a disruptive event; this is the foundation of SCRES (Ponomarov and Holcomb 2009). In the face of a worldwide crisis and disruptions in natural and energy resource SCs, manufacturing businesses must enhance the use of manufacturing equipment and restructure supply networks using reshoring and nearshoring techniques (Fernández-Miguel et al. 2022; Van Hoek and Dobrzykowski 2021). Both scholars and practitioners have recently remarked on the rise of reshoring, often known as backshoring (Kinkel 2012; Soroka 2016). Reshoring, which involves regionalization or the minimization of exposure to geographically separated economies beyond the home region, allows the number

and intensity of international links to be lowered; this can also reduce vulnerability to foreign shocks (Marvasi 2022).

In this context, the term manufacturing reshoring attracted initial interest among practitioners and has recently gained traction among academics (Barbieri et al. 2018; Fratocchi et al. 2015; Fratocchi et al. 2016; Stentoft et al. 2016) and policymakers (De Backer et al. 2016; Guenther 2012; Livesey 2012). Reshoring is defined as the geographic repatriation of a company's practical, value-creating operations to their original location. In this process, all of the outsourced business practices (e.g., production, staff, services, and manufactured items) are relocated from offshore facilities to the original place or nation from which they were offshored. This process is also referred to as inshoring or backshoring.

A new body of literature on the benefits of globalization and the resilience of GVCs is still evolving; thus, one of the latest disruptions, the COVID-19 outbreak, offers a unique chance to grasp how GSCs function and, thus, build resilience in SCs (Chepeliev et al. 2022). Furthermore, the scientific literature is lacking data on reshoring with regard to the interconnectivity of corporate networks and systems that span either domestic or offshore nations (Baraldi et al. 2018; Choudhary et al. 2022). The majority of the studies that were investigated in the literature focused on difficulties such as outsourcing provider selection, outsourcing management, or outsourcing site selection, as well as concerns with set criteria and carefully selected providers and locations. As a result of the effects of crises such as globalization, the economic crisis, and pandemics, businesses that have experienced substantial problems with risk management are starting to consider changing their outsourcing strategies rather than the suppliers. Therefore, we can conclude that there is no study that analyzes various criteria and establishes which outsourcing strategies—offshoring, onshoring, reshoring, and nearshoring—are best in terms of these criteria. In the existing studies, there is a lack of real-world examples for comprehending the interdisciplinary outsourcing approach, such as reshoring and nearshoring strategies, to encourage its adoption in GSCs to facilitate SCRES. Therefore, the underlying motivation of the current study is the necessity of developing a systematic approach to SCRES by implementing different outsourcing strategies (e.g., reshoring and nearshoring strategies) to address interruptions caused by diverse risks. Accordingly, this research tries to bridge the gap between the existing knowledge and the implementation of GSC risk management by investigating and conceptualizing the relationship between SCRES and outsourcing options. To discover the most resilient outsourcing approach,

four alternative outsourcing strategies (offshoring, onshoring, reshoring, and nearshoring) were examined using certain criteria in terms of the outsourcing concerns present in the literature. The research questions (RQs) are as follows:

RQ1. What are the interactions between outsourcing strategies (offshoring, reshoring, nearshoring, and farshoring) and SCRES?

RQ2. What are the core values for selecting the outsourcing strategies that businesses have used to manage the risks, uncertainties, and disruptions engendered by globalization, crises, and pandemics and to ensure resilience?

RQ3. Which outsourcing strategies—offshoring, onshoring, reshoring, and nearshoring—are appropriate for the development of SCRES in the face of risks, uncertainties, and disruptions in the manufacturing industry?

To respond to these RQs, first, the existing literature was examined to determine the criteria used by firms when considering outsourcing strategies, and the criteria set for the further phases of the study was developed from this review. A group of experts, using the Delphi approach, discussed the obtained criteria set to determine the criteria for outsourcing solutions to equip firms with resilience. The four main outsourcing strategies—offshoring, onshoring, reshoring, and nearshoring—were each evaluated using predetermined criteria to determine the best option for the particular companies operating in the manufacturing sector. Finally, considering the most advantageous outsourcing method thus determined, how resilient SCs can be constructed for the industrial sector is discussed.

The remainder of this paper is arranged as follows. The second section presents a detailed investigation of the existing literature on the resilience factors associated with the decision-making concerning which outsourcing technique is suitable for risk management and the theoretical background of outsourcing techniques. The third section contains the methodological information and formulation of the method that has been used throughout this paper, namely the best worst method (BWM) and Elimination Et Choix Traduisant la Realité (ELECTRE). The case study, which is the application stage of the methodology with real-world cases, is presented in the fourth section. The results of the method are explained and interpreted in the fifth section. The discussion of the methodology and topic, the comparison of the results with those of other studies, and the corresponding implications are presented in the sixth

section. Finally, the conclusion section presents the summary, limitations, and contributions of this study, in addition to future research ideas.

2. Building a Conceptual Framework

2.1 Literature Review about Supply Chain Resilience and Outsourcing Techniques

This section of the study focuses on the existing literature related to the topics such as SCRES, outsourcing strategies, and globalization, with the aim of addressing the issues confronted. For instance, Um & Han (2021) delved into the connections between resilience, mitigating measures, and hazards in the global supply chain. It pinpoints internal risk elements including procurement, production, and delivery and investigates defense mechanisms for increased resilience. SC resilience is used in the study as a dynamic capacity. König & Spinler (2016) examined the effects of logistics outsourcing on shippers' supply chain vulnerability using a risk management framework with the goal of assisting practitioners and academics in comprehending crucial elements.

The majority of SCRES studies found in recent literature have focused on general SC issues, such as interruptions, risks that occurred, provider selection issues, vendor location selection issues, and risk-reduction tactics. To identify the significant categories in which SCRES had been studied and the crucial research problems in each category, Mandal (2014) presented a thorough assessment of the subject. Roberta Pereira et al. (2014) examined how procurement could help identify and manage the problems affecting SCRES, concentrating on both internal and external corporate initiatives. Furthermore, Nicoletti (2016) also focused on how procurement may assist manage operational risks, particularly those resulting from inadequate or failing processes, human resources, internal systems, or external events, and the significance of enhanced resilience in outsourcing methods to minimize these risks.

Namdar et al., (2018) analyzed how the coronavirus outbreak affects supply chain vulnerabilities and global commerce, emphasizing the necessity of a resilience policy framework and contingency plan. It offers a fresh framework for making decisions on supply-side resilience. Das et al., (2021) investigated how the coronavirus outbreak affects supply chain vulnerabilities and global trade dynamics, emphasizing the necessity for a contingency plan and regulatory framework to maintain resilience. In order to create a resilient supply chain, it assesses strategic interventions, identifying crucial obstacles, prioritizing causal-effect groups, and identifying implications and methods.

The significance of risk management in global supply chains is discussed in Colicchia et al., (2010)'s study, with an emphasis on inbound supply risk resulting from growing distances between sources and markets. Gunasekaran et al. (2015) investigated the relationship between SCRES complexity and proactive management techniques, particularly as a result of global sourcing (GS) policies. They sought to clarify GS characteristics, assess it through the lens of complexity theory, examine GS resilience, and offer solutions to difficult problems. Huq et al., (2016) examined at how disruption factors affect the supply chain configurations (SCs) for European pharmaceutical companies. Three SC setup scenarios are listed: insource offshore, outsource offshore, and outsource nearshore. Globally, the source and destination of products are being affected by the reorganization of manufacturing companies. Cohen et al., (2018) offered a thorough, worldwide perspective on sourcing for the manufacturing industry. Harper, (2022) urged US-based businesses to switch to continental and Western Hemisphere sourcing choices by identifying dangers related to offshoring suppliers and sourcing solutions to Asian markets.

To build resilient systems for reducing ripple effects and boosting sustainability, Ivanov (2018) examined SC disruption propagation and sustainability variables. The simulation-based analysis helped identify characteristics that could reduce risk and improve performance. Jessin et al. (2022) focused on building a pseudo-resilience concept for sustainability and detecting weaknesses in supplier selection and assessment. To create a resilient SC, Sabouhi et al. (2018) proposed a hybrid strategy combining data envelopment analysis (DEA) with mathematical programming; they created a two-stage probabilistic-stochastic programming model for supplier selection and SC design under interruption and operational risks and used a fuzzy DEA model to assess the efficiency of possible providers. In addition, López and Ishizaka (2019) developed a hybrid FCM-AHP method that can assist practitioners in assessing alternative sites based on their influence on resilience by forecasting the effects of offshore outsourcing location decisions on SCRES and quantifying uncertainty in causal links.

2.1 Supply chain resilience

The dynamic nature of present-day SC networks has resulted in a high level of ambiguity regarding many of its characteristics and uncertainties, which may pose a danger to the entire SC network (Sabouhi et al. 2018). A malfunction, subsystem failure, or delay in any of the SC tiers has the potential to significantly impact the entire SC, resulting in significant supply loss

or, in the worst-case scenario, full SC disruption. As the SC network may fail easily and disrupt the entire system, it is critical that the system be long-lasting and resilient. Therefore, the capacity of business organizations to foresee such effects is a vital fundamental skill they need to ensure that they can react and rebound in a short period before the next significant event; this is what distinguishes high-performance organizations from the rest (Gunasekaran et al. 2015). Hence, organizations across the globe must increase the resilience of their GSCs to handle future shocks (Das et al. 2021; Linton and Vakil 2020) and risks.

For successful SC performance, companies must create SCRES, which is defined as the capacity of an SC to adapt to interruptions and rebound efficiently (Qader et al. 2022). There are various definitions of resilience and the corresponding SCRES terms. SCRES is defined as the responsive abilities of an SC, namely preparing for unpredictable circumstances, reacting to interruptions, and recovering from them while preserving operational continuity at the optimum consistency in terms of interconnectivity and control over both structure and function (Ponomarov & Holcomb 2009). The adaptive resilience capacity is organized as three separate disruption stages in the SC: “readiness,” “responsiveness,” and “recovery” (Sheffi and Rice 2005). In this context, businesses must be aware of the probability of a catastrophic event or risks in the future and adopt proactive and reactive actions so that they can respond swiftly to the consequences of these risks and related disruptions, with the aim of eliminating these effects. Building resilience may ease the impacts and hazards of these risky circumstances.

Building resilience requires encouraging balanced diversity, localization, and redundancy alternatives, as well as adopting new technology to improve transparency in GSCs (Sajjad 2021). In addition, resilience includes several aspects of preparedness, reaction, and recovery that are aimed at handling an unpredictable and inconsistent environment while maintaining proper operations (Ali et al. 2021; Qader et al. 2022). For this purpose, various resilience methods have been created and adopted by companies. These effective resilience methods, such as multiple sourcing, partnering with backup facilities, outsourcing, excess inventory, capacity advancement, demand deferral, pre-positioning emergency inventories, supplier selection, and order allocation, are necessary to construct a responsive and robust SC network in the face of interruptions (Bunschuh et al. 2006; Choi et al. 2012; Costantino et al. 2012; Hasani and Khosrojerdi 2016; Sabouhi et al. 2018; Tang 2006).

2.2 Outsourcing techniques: onshoring, offshoring, reshoring, and nearshoring strategies for supply chain resilience

The COVID-19 pandemic, catastrophic weather occurrences, and trade tensions fueled by rising economic nationalism and protectionism have put global value networks to the test (Chepeliev et al. 2022). As GSCs undergo unprecedented interruptions resulting from the COVID-19 pandemic, businesses are increasingly concerned about how to thrive and succeed in the current global economic market (Birkinshaw 2020; Gölgeci and Gligor 2022;). Furthermore, the complexity of constructing GSC networks has increased because GSCs expanding beyond borders has led to a greater lead time being required across SC facilities to traverse increasing distances (Hasani and Khosrojerdi 2016). As GSCs are complicated and prone to interruptions, hazard and risk management has been brought under control using various resilience strategies in an attempt to be more robust when handling these hazards.

For instance, GS has reduced manufacturing costs through cheap wages or employment costs and economies of scale, but recent research indicates that corporations are finding it less cost-efficient; thus, many firms first explore outsourcing arrangements, generally overseas, to benefit from lower tariffs and taxes, lower labor costs, a 24-hour-a-day workforce, and the opportunity to recruit individuals with specific skill sets in their home country (Gary et al. 2013). Outsourcing is one of these resilience measures and GS techniques, and this paper is based on a broad discussion of outsourcing approaches and a description of which ones can be beneficial under certain risks. Outsourcing involves hiring third parties or other firms to be liable for a scheduled or ongoing activity, such as performing duties, managing operations, and delivering services, externally. Its aim is to reduce SC operations and decrease the number of services provided internally in the organization. The benefits businesses gain from outsourcing include various types of costs (e.g., feasibility study costs and hidden costs); theft and piracy; losses in shipping; distinct and varying auditing processes of countries; workforce recruitment, training, and orientation; and difficulties with communication and culture (Milligan and Hutcheson 2006). Therefore, investigating these outsourcing factors for SCRES can yield fresh insights into how businesses can establish and sustain adaptable SCs, as well as select effective outsourcing techniques for their organizational characteristics and risk management in the face of varied risks and disruptions.

There are four major types of outsourcing strategies: offshoring, onshoring, reshoring, and nearshoring. Onshoring—often known as domestic outsourcing—is the inverse of offshore outsourcing. Onshoring aims to maximize quality by reducing costs in business processes, while company activities are performed by third parties that are located within national boundaries. In contrast, offshoring is the movement or transfer of company activities, often an operational process (such as production) or supporting processes, to third parties located in a foreign nation. There are two types of offshoring, which are specialized versions of it: nearshoring and farshoring. Nearshoring is the relocation of outsourced business operations to nations near or neighboring the country of origin, whereas farshoring is the outsourcing of these business activities to third parties that are far from the country of origin. Reshoring, also known as inshoring or backshoring, is the territorial repatriation of a company's outsourced business operations (such as production, people, services, and manufactured products) to their original site. Fig. 1 and Fig. 2 demonstrate the differences between these intertwined and integrated terms based on two unique locations, namely the United States and Europe.

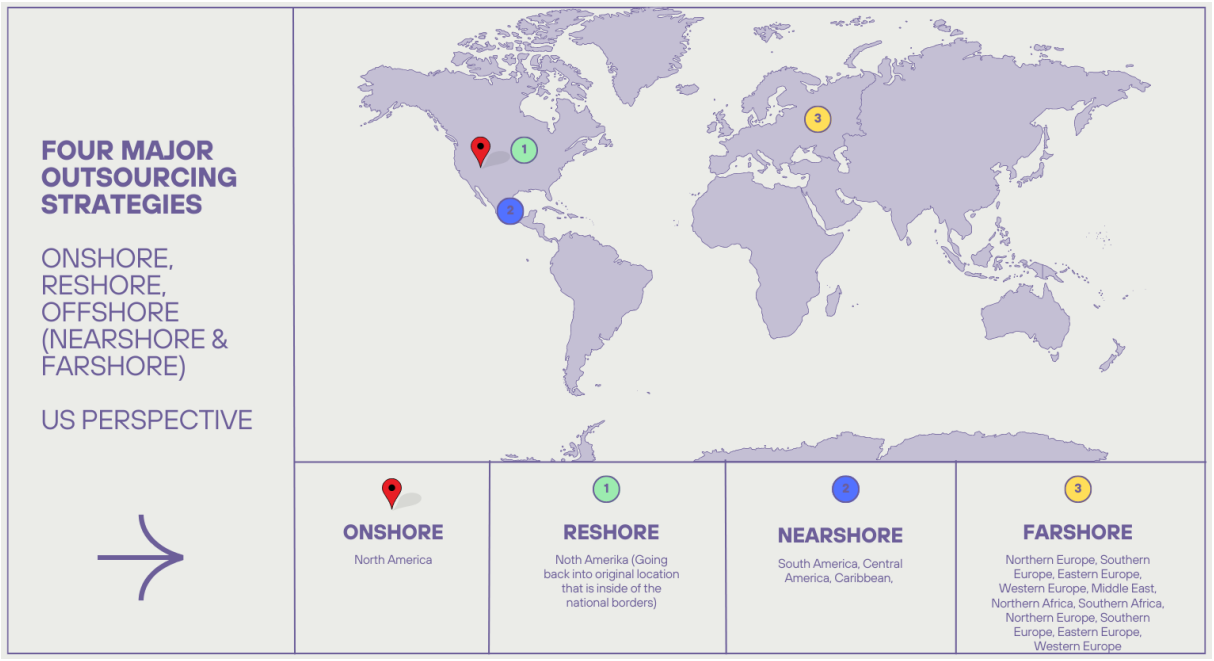

Fig. 1 The four major outsourcing strategies demonstrated based on the United States

Fig. 2 The four major outsourcing strategies demonstrated based on Europe

To ensure the system would be resilient, the most frequently considered factors for outsourcing were examined based on the existing literature and analyzed to determine which outsourcing strategy would be the best fit for our case study company (see Table 1). The conceptual framework thus developed is presented in Table 2.

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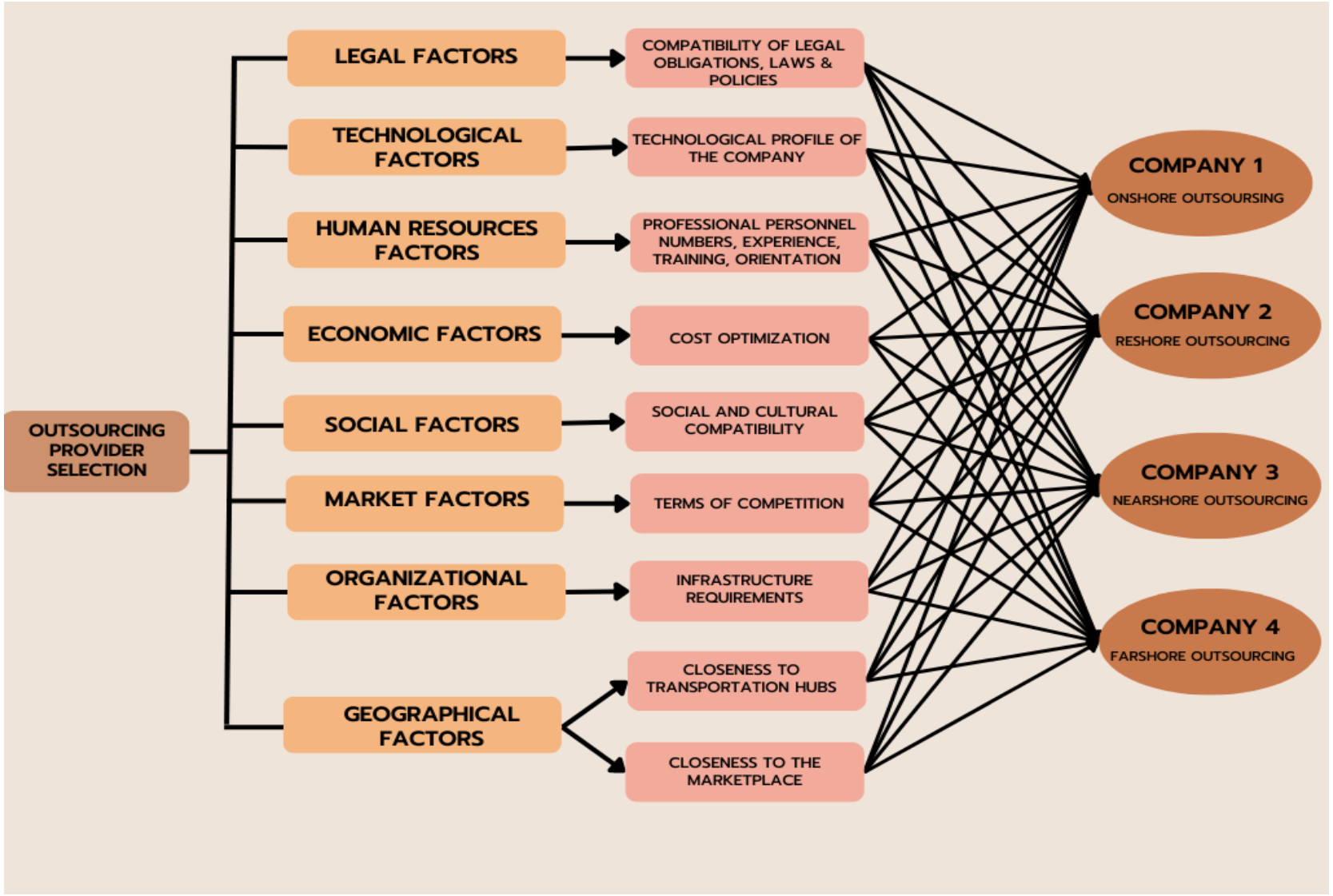
Table 1 Outsourcing provider selection criteria and their definitions

DIMENSIONS	*NO.*	*OUTSOURCING PROVIDER SELECTION CRITERIA*	*DEFINITION OF THE CRITERIA*
LEGAL FACTORS	C1	Compatibility of legal obligations, laws, and policies	Local actions and laws are frequently implemented by governments in accordance with their treaty commitments and duties. These legal requirements, regulations, and policies (e.g., security policies, privacy policies, data security and integrity, and trade policies) govern the implementation of industry policies, such as international trade and investment standards and local content policies. Thus, the compatibility of these legal obligations with the outsourced company is crucial for the continuity of manufacturing operations.
TECHNOLOGICAL FACTORS	C2	Technological profile of the company	As digital technologies are the future of outsourcing, new technologies emerge on a regular basis. In this regard, the increasing scarcity of technology skills is an issue faced by all organizations that want the technology profile of the company to which they will be outsourcing. Businesses that want to thrive must spend more on technology (e.g., software and hardware technique capacity and innovation).
HUMAN RESOURCE FACTORS	C3	Number, experience, training, and orientation of professional personnel	Human resources provide firms with improved performance, quality, and efficiency; a competitive advantage; and specific technical skills and expertise when they outsource. Thus, the outsourced organization's workforce, quality, qualification, training, and knowledge are all critical to the continuity, problem-ability, and flexibility of production.
ECONOMIC FACTORS	C4	Cost optimization	Firms that have outsourcing agreements undergo a significant cost-cutting exercise to lower operating expenditures. To achieve more with fewer resources, sourcing managers must continually examine the difficulties that their firms face and aim to decrease expenses such as lower overheads, ensure financial stability, and so on.
SOCIAL FACTORS	C5	Social and cultural compatibility	Cultural compatibility (enterprise culture, organization culture, communication, etc.) necessitates an awareness of diverse cultures, as well as respect for their traditions and values, while mitigating the negative impacts of industrial flexibility on financial performance. When selecting the firm to outsource to, entrepreneurs and employees may optimize the benefits of outsourcing by selecting locations where their national cultures can coexist while appreciating each other's peculiarities.

MARKET FACTORS	C6	Terms of competition	Competitiveness is required at all levels in global marketplaces, and competition has a substantial influence on supply chain structure, company performance, and business continuity. Companies that utilize an outsourcing strategy strive to obtain and keep a competitive edge by converting increases in productivity into reduced profit margins.
ORGANIZATIONAL FACTORS	C7	Infrastructure requirements	Infrastructure outsourcing is a subcontracting service in which a third party manages an organization's infrastructure (information technologies, location, machinery and equipment, etc.), systems, and applications. In this context, the services offered by the firm to be outsourced, such as supply control and monitoring, system documentation, security, and completeness of process configuration capability, are dependent on its infrastructure.
GEOGRAPHICAL FACTORS	C8	Closeness to transportation hubs	Shipping management and the associated expenses are important factors to consider when outsourcing, as they have a direct influence on profitability and competition. While corporations typically consider outsourcing, closeness to hubs, absence of traffic, proximity to the source, and other variables, transportation has become at least as essential.
	C9	Closeness to the marketplace	Locations where the market is situated and where competition is fierce are particularly vital with regard to outsourcing because closeness to the market provides various benefits, such as keeping these enterprises informed of current developments, allowing them to upgrade, and facilitating prompt responses to dangers.

Table 2 Conceptual framework of the study



3 Methodology

This section contains a three-integrated strategy for outsourcing provider selection difficulties. Initially, a committee of specialists from the manufacturing sector analyzed and selected the Delphi technique to determine the criteria set specified with regard to the aspects considered for outsourcing through resilience. Following the establishment of the criteria, the weights of each criterion were computed using one of the multi-criteria decision-making (MCDM) methods, namely the BWM. Subsequently, using the criterion weights for the criteria set, the ELECTRE technique was initiated for selecting the best outsourcing provider site among the possibilities (Companies 1, 2, 3, and 4). The flowchart of the methodology section is presented in Fig. 3:

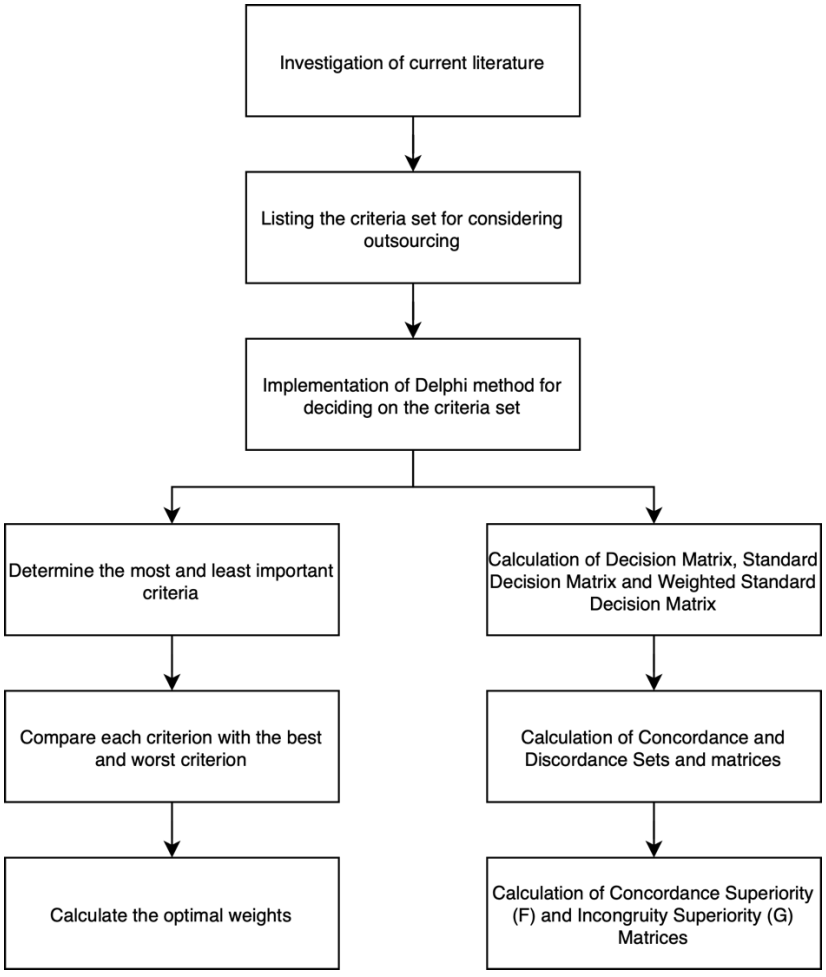


Fig. 3 Methodology flowchart

3.1 Multi-criteria decision-making

MCDM is a decision methodology that is extensively used in the fields of science, industry, government, and engineering to enhance decision quality by making the judgment call process

clearer, more logical, and more efficient (Wang and Triantaphyllou 2008). The MCDM technique's capacity to handle complicated decision-making circumstances involving numerous criteria has led to it being selected for assessing critical criteria for outsourcing strategies and attaining SCRES. Considering a variety of criteria and circumstances when choosing outsourcing solutions is part of the complex idea of SCRES. Using MCDM methodologies, various options can be compared and assessed based on these standards in an organized manner. Decision-makers can employ MCDM to examine several scenarios and their consequences, weight each criterion based on relevance, and take into account numerous dimensions concurrently. The various elements that affect outsourcing choices and SCRES may be evaluated thoroughly and methodically using MCDM methodologies. In this context, the organization or business making the outsourcing choice is usually the unit of analysis. Understanding the decision-making process and the standards by which various outsourcing initiatives are assessed is the main goal. For gathering data during research into outsourcing strategies and SCRES, academics have used purposive sampling to choose particular firms or businesses that operate in manufacturing firms and have used outsourcing strategies.

3.1.1 Delphi method

Delphi is a structured group communication technique for complicated issue-solving that involves anonymous participants providing numerical responses to queries about event likelihood and date-in-time. For effective communication, structured communication includes individual feedback, group evaluation, revision opportunities, and anonymity (Linstone and Turoff 1975). Individuals can edit or repeat their comments after a collection of answers has been formed. Up to a set ending point, such as the number of repetitions, consensus, proven dissensus, and stability of outcomes, the repeated supervised feedback process continues (Grime and Wright 2016). The Delphi method was employed in this study to gather and examine the criteria set and condense it into a form suitable for the methodologies utilized. A panel of academic and business specialists discussed the validity and relevance of the study's criteria.

3.1.2 Best worst method

AHP and analytical network process (ANP) are the two most commonly used ways to weight each criterion. A more recent technique for this is the BWM, which Rezaei introduced in 2015. By comparing the most important criterion to the others and the other decision criteria to the

least important criterion, the BWM calculates the weights of the decision criteria. The BWM was chosen for this study because it requires fewer comparisons than AHP or ANP. The BWM is a vector-based MCDM technique. Fewer comparisons mean that the solution can be found in less time and with less complexity. Furthermore, the BWM is more trustworthy than other methods because it utilizes a mathematical model (Sagnak et al. 2021). The choice criteria must be weighted using the BWM in five steps:

Step 1: Establish a set of choice criteria $\{c_1, c_2, \ldots, c_n\}$.

Step 2: Establish a set for each of the most and least important criteria. The c_B and c_W variables can be used to denote the most and least important criteria, respectively.

Step 3: Compare each criterion with the most important criterion. The best-to-others vector will be yielded after applying this step. This vector is denoted by $\tilde{A}_B = (\tilde{a}_{B1}, \tilde{a}_{B2}, \ldots, \tilde{a}_{Bn},)$.

Step 4: Compare each criterion with the least important criterion. This process will result in the others-to-worst vector, which is denoted by the expression $\tilde{A}_W = (\tilde{a}_{1W}, \tilde{a}_{2W}, \ldots, \tilde{a}_{nW})^T$.

Step 5: Calculate the optimal weights. All variables must be larger than or equal to 0. The total weights should equal exactly 1. These constraints can be used to develop the following mathematical model:

$$\text{minimize} \qquad \max\left\{\left|\frac{w_B}{w_j} - a_{Bj}\right|, \left|\frac{w_j}{w_W} - a_{jW}\right|\right\}$$

This is subject to the following:

$$\sum_{j=1}^{n}(w_j) = 1$$

$$w_j \geq 0$$

It is assumed that this model can be transformed into the constrained mathematical model shown below:

$$\text{minimize } \xi$$

$$\left|\frac{w_B}{w_j} - a_{Bj}\right| \leq \xi$$

$$\left|\frac{w_j}{w_W} - a_{jW}\right| \leq \xi$$

$$\sum_{j=1}^{n}(w_j) = 1$$

$$w_j \geq 0$$

3.1.3 ELECTRE method

The ELECTRE method was first developed by Benayoun in 1966. It is a complete evaluation method that also attempts to consider various alternatives, each of which is characterized using a range of criteria (Vahdani et al. 2010). With the ELECTRE method, which is one of the mathematical programming techniques for optimization purposes, the decision-maker can include many quantitative and qualitative criteria in the decision-making process, weight the criteria in line with the purpose, and determine the most appropriate alternative by adding their weights. ELECTRE I, which was the first one introduced, fit incompatibility or over-rating methods; they differ in terms of the preference structures they contain and whether they use weight information and results, and they have names such as ELECTRE II, III, and IV as well as ELECTRE TRI. ELECTRE is a family of MCDA techniques initially suggested by Bernard Roy in Europe in the mid-1960s. These methods use the top-ranking relationship, and for the distinct elements of a set of alternatives A, the selection of an element results in categorizing the alternatives as “acceptable” or “unacceptable” (among other types of categorization) and in rating the alternatives (Bouyssou 2001). The steps of the method are explained below. ELECTRE was created to allow organizations to work on real-world selection issues and allow decision-makers to extend the traditional weighted summation method (Botti and Peypoch 2013).

Step 1: Calculate the decision matrix. The rows of the decision matrix represent the criteria of the decision problem, and the columns represent the alternatives. Matrix A is the first dataset objectively formed by the decision-makers. Decision Matrix A is expressed as follows:

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}$$

In the A_{ij} matrix, m represents the number of alternatives and n the number of criteria.

Step 2: Calculate the standard decision matrix. Each element of Standard Decision Matrix X can be found by starting from the elements of Decision Matrix A and using the formula given below:

$$x_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}}$$

In this process, the goal is to evaluate the relationship of the first alternative with the first criterion and to determine its weight in terms of the other alternatives. As a result of the evaluations, Standard Decision Matrix X can be expressed as follows.

$$X_{ij} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

Step 3: Calculate the weighted standard decision matrix. Each criterion of the decision problem may have different degrees of importance for the decision-maker. To transfer these differences to the solution process of the ELECTRE method, Weighted Standard Decision Matrix Y is created. The decision-maker should first determine the weights (w_{i}) of the criteria. The sum of these weights must be equal to 1 according to the formula given below:

$$\sum_{i=1}^{n} (w_i) = 1$$

Following this, each column element of Standard Decision Matrix X is multiplied by the corresponding w_i value, and Weighted Standard Decision Matrix Y is formed; it is given below:

$$Y_{ij} = \begin{bmatrix} w_1x_{11} & w_2x_{12} & \cdots & w_nx_{1n} \\ w_1x_{21} & w_2x_{22} & \cdots & w_nx_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ w_1x_{m1} & w_2x_{m2} & \cdots & w_nx_{mn} \end{bmatrix}$$

Step 4: Calculate (C_{kl}) concordance and (D_{kl}) discordance sets. The elements of Weighted Standard Decision Matrix Y are used to create fit sets. Alternatives are compared among themselves, considering the criteria. The conformity and incompatibility sets are determined with the help of the formula given below:

$$C_{kl} = \{j, y_{kl} \geq y_{lj}\}$$

Step 5: Calculate (C) concordance and (D) discordance matrices.

(C) In the calculation of the fit matrix, the fit sets determined in the previous stage are used. The size of Matrix C is (mxn). For k = l, no value is written for the relevant element. The elements of Fit Matrix C can be calculated using the following formula.

$$C_{kl} = \sum_{j=C_{kl}} w_j$$

(D) The elements of Mismatch Matrix (d_{kl}) can be found using the following formula:

$$d_{kl} = \frac{\max\limits_{j \in D_{kl}} |y_{kj} - y_{lj}|}{\max\limits_{j} |y_{kj} - y_{lj}|}$$

Similar to Concordance Matrix *C*, Incompatibility Matrix *D* has a size of (mxn). For k = l, no value is written for the relevant element. Accordingly, Mismatch Matrix *D* is as follows:

$$D = \begin{bmatrix} - & d_{12} & \cdots & d_{1m} \\ d_{21} & - & \cdots & d_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ d_{m1} & d_{m2} & \cdots & - \end{bmatrix}$$

Step 6: Calculate concordance superiority (F) and incongruity superiority (G) matrices.

The size of Fit Superiority Matrix (F) is mxn, and its elements are found by separately comparing the fit threshold value with the elements of the fit matrix. The fit threshold value is calculated using the following formula:

$$\underline{c} = \frac{1}{m(m-1)} \sum_{k=1}^{m} \sum_{k=1}^{m} C_{kl}$$

The size of Mismatch Superiority Matrix (G) is mxn. Before Matrix G is formed, the mismatch threshold must be calculated. This threshold value can be calculated using the following formula:

$$\underline{d} = \frac{1}{m(m-1)} \sum_{k=1}^{m} \sum_{k=1}^{m} d_{kl}$$

Step 7: Calculate the total dominance matrix. The values of the elements of the total dominance matrix are formed by the reciprocal product of the elements of the congruent supremacy and incompatibility supremacy matrices. As the elements of Matrices F and G are 1 and 0, the elements of Matrix E will also be 1 or 0.

Step 8: Calculate the order of priority alternatives. The rows and columns of the total dominance matrix represent the priorities of the alternatives.

4 Case study and results

The main objective of this study is to select the best outsourcing option, strategy, and location for a company to reduce the effects of increasing SC risks and unforeseen disasters and interruptions caused by the acceleration of globalization as well as the disruptions that significantly affect SCs' resilience and transparency. To handle disruptions, developing reactive and proactive solutions, ensuring agile actions, and achieving resilience and transparency through GSCs are necessary; for this purpose, outsourcing literature was extensively reviewed to guarantee SC agility for risk management, and the relevant aspects discovered were listed to be used as the criteria set. The obtained criteria or factors were developed by reviewing the literature in all sectors in general, without focusing on any specific sector; therefore, these lists of criteria can be adapted to any sector. This study's generalizability is thus assured.

The manufacturing industry was chosen for the implementation stage of this study. The company selected for our case study is a multinational manufacturer of electronics with a focus

on memory chips. The business runs production facilities and research centers in specific regions of the world. DRAM and NAND flash memory, crucial parts of cellphones, PCs, and servers are this company's specialties. This company, which is currently onshoring in a foreign nation, wants to collaborate with a new manufacturing facility among the sites identified because of cost-cutting and regulatory policy-related requirements. For enterprises, outsourcing the manufacturing of electronics to specialist companies has several advantages. These companies are skilled at creating electrical gadgets and components, which enables them to effectively utilize their abilities and assets. They retain quality control, compliance, and risk management while ensuring cost savings, flexibility, and scalability. Additionally, outsourcing yields creative and competitive goods by facilitating the utilization of the most recent equipment, production methods, and technologies without requiring a substantial financial commitment.

After a detailed investigation of the existing literature, the criteria set to be used in the methodology of this study was decided through the Delphi method. Eight experts, comprising professionals from related fields within the industry (i.e., the manufacturing industry) and academicians, collaboratively discussed the most important factors affecting outsourcing provider selection for SCRES under risky situations, with the aim of adopting corrective measures. The experience of the professionals ranged from 9 to 17 years in the industry or in academia. While five of the experts—a product development engineer, a quality assurance engineer, an SC manager, a process engineer, and a project manager—were selected from the business sphere, three had academic backgrounds. Following this, nine criteria were determined: C1: compatibility of legal obligations, laws, and policies; C2: technological profile of the company; C3: number, experience, training, and orientation of professional personnel; C4: cost optimization; C5: social and cultural compatibility; C6: terms of competition; C7: infrastructure requirements; C8: closeness to transportation hubs; and C9: closeness to the marketplace. Four companies (Companies 1, 2, 3, and 4) were selected as alternative outsourcing locations, with each one offering different outsourcing strategies (onshoring, reshoring, nearshoring, and farshoring).

Prior to using the ELECTRE technique to identify the best outsourcing provider, the BWM was utilized to establish the weights to be used in ELECTRE. The aforementioned eight experts picked the best and worst BWM criteria and graded them using the nine-point scale. The values

to be given and their equivalents are given in Table 3. These values were collected in a common matrix and used as the input for the BWM.

Table 3 The adopted scale, numerical ratings, and their descriptions

Numerical Ratings	*Scale Description*
1	Equally important
3	Weakly important
5	Strongly important
7	Very strongly important
9	Extremely important
2, 3, 4, 6, 8	Intermediate value between adjacent scales

As a result of the BWM, the weights of the criteria were found, and these weights were used as input in the next steps of the ELECTRE method. The criteria weights found are given in Table 4.

Table 4 The results and corresponding weights provided by the best worst method

NUMBER OF CRITERIA	**DEFINITION OF CRITERIA**	**WEIGHTS OF CRITERIA**
C1	Compatibility of legal obligations, laws, and policies	0.14
C2	Technological profile of the company	0.08
C3	Number, experience, training, and orientation of professional personnel	0.05
C4	Cost optimization	0.42
C5	Social and cultural compatibility	0.05
C6	Terms of competition	0.06
C7	Infrastructure requirements	0.05
C8	Closeness to transportation hubs	0.08
C9	Closeness to the marketplace	0.08

To facilitate a comparison, four companies were determined, interviews were conducted with the eight experts, and the companies were asked to be scored according to the criteria. These values were averaged similarly as in the previous steps and turned into a single matrix to be used in the ELECTRE method. This matrix can be seen in Table 5.

Table 5 ELECTRE results

CRITERIA	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**
Company 1	5.13	6.25	5.88	5.88	5.50	7.13	7.13	6.13	5.88
Company 2	8.13	8.50	7.63	8.13	9.75	7.88	7.00	7.25	7.38

Company 3	5.50	5.75	5.13	5.25	6.75	6.38	4.75	5.63	5.88
Company 4	5.75	4.25	4.25	8.13	3.88	5.63	5.38	3.75	3.50

Using this matrix, the ELECTRE method was applied, and a total dominance matrix was obtained. The values in this matrix show dominance among companies. A value of 1 in the table indicates that the company in the row dominates the company in the column. A value of 0 indicates that the company in the row has no dominance over the company in the column. The total dominance matrix is presented in Table 6.

Table 6 The total dominance matrix

CRITERIA	COMPANY 1	COMPANY 2	COMPANY 3	COMPANY 4
Company 1		0	1	0
Company 2	1		1	1
Company 3	0	0		0
Company 4	1	0	1	

As seen in Table 6, the first company has dominance only over the third company. The second company has dominance over all other companies. The third company has no dominance over any company. Finally, the fourth company has dominance over the first and third companies. Thus, the order of dominance among the four companies is 2>4>1>3.

5 Discussion and implications

Due to globalization and SC hazards such as pandemics, firms have encountered several financial, political, social, and organizational challenges. Factors such as increasing costs, resource constraints, and technology and innovation infrastructure have increased the need for considering more cost-minimizing alternatives for various operations. Companies seek to respond to these growing demands and expenses while taking advantage of the opportunities provided by globalization; consequently, they have increasingly turned to third-party providers and outsourcing providers to satisfy this requirement. Therefore, by adopting outsourcing, businesses aim to lower their own risk of operational interruption and become resilient, in addition to successfully managing these suppliers while limiting the danger of injuring their customers. Highly resilient firms are far more likely to survive, especially in times of crisis. In this context, resilience is critical to the survival of organizations during times of crisis, and outsourcing is one strategy that can strengthen business resilience.

The concept of outsourcing involves obtaining various services, such as the necessary expertise, infrastructure, technology, and qualified personnel, to produce a product or provide a service, without having anything specifically. Various outsourcing-related topics, such as provider and site selection, risk management, relationship management, performance assessment, knowledge transfer, cultural and social consequences, governance, innovation, and cultural and ethical disparities in outsourcing agreements, appear to be the most commonly discussed subjects in the existing literature. There exist several studies that integrate these concepts, such as Canello (2017), Espino-Rodríguez (2023), Leenders and Giustozzi (2019), López and Ishizaka (2019), Milligan and Hutcheson (2006), Nicoletti (2016), Pereira et al. (2019), Sugimoto and Tanimizu (2018), Viitanen and Kingston (2014), and Um and Han (2021). Furthermore, various studies have examined the outsourcing provider and location selection problem, including Chang et al. (2012), Chen (2012), Cui et al. (2012), Li and Wan (2014), Li et al. (2014), Liou et al. (2011), Low and Hsueh (2012), and Perçin (2019).

The fundamental contribution of this study to the existing literature in this area is the identification and analysis of the essential aspects or criteria that impact the resilience of SCs in vulnerable positions from the standpoint of outsourcing as a solution mechanism. Furthermore, this paper provides insights into outsourcing provider selection by adopting an MCDM approach (BWM and ELECTRE). The uncertainties, interruptions, and disruptions arising from the COVID-19 pandemic, including raised expenses, risks, and supply concerns, forced the case study company to reevaluate its outsourcing plans. To discover a solution to this problem, a comprehensive literature analysis was undertaken based on the factors or criteria considered by organizations when outsourcing. A group of specialists from the organization weighted the predetermined criteria set using the BWM; subsequently, ELECTRE was employed to find the best outsourcing provider selection alternative. The results of the methodology section suggest that reshoring as an outsourcing strategy is the best fit for the case study company under post-pandemic conditions.

The manufacturing sector is one of the sectors in which reshoring activities have been largely adopted and may increase in the future. The practice of relocating manufacturing operations closer to the home market, known as manufacturing reshoring, is becoming increasingly favored due to various factors, including growing labor prices, transportation expenses, SC complexity, long lead times, the need to avoid offshore risks, cultural and social disjointedness, and inventory buffers.

The reason reshoring has become one of the most preferred methods is that it lowers costs, enhances process control, increases product quality, complies with regulatory standards, boosts customer happiness, and lowers the risk of quality-related problems. Additionally, it improves SCRES by lowering reliance on overseas suppliers, cutting down on lead times, and increasing responsiveness to interruptions. Trade disputes, increased labor prices in offshore nations, sustainability-related issues, and, most significantly, SC interruptions resulting from the COVID-19 outbreak have all driven reshoring (Butt 2021; Choudhary et al. 2022; Gray et al. 2013). Furthermore, as manufacturers place a greater focus on risk management in their SCs because of the difficulties they face, many businesses attempt to diversify certain aspects of their production by outsourcing, reducing costs, providing flexibility and resistance, and adapting reshoring systems as an outsourcing strategy.

The main contribution of this study to the literature is the emphasis placed on the need to take outsourcing strategies and components into account to achieve resilience in the face of changing conditions, interruptions, and increased costs in the context of the global corporate environment. Businesses may strive to reduce risks and improve the resilience of their SCs by comprehending and adopting the proper outsourcing techniques.

5.1 Practical implications

To establish SCRES, electronic manufacturing companies that are planning to apply reshoring should be careful about the following: choosing the right suppliers, diversifying, ensuring collaboration, assessing risks, formulating backup plans, and localizing crucial procedures. By investing in real-time visibility and transparency, one may see issues early, act swiftly, and work well with suppliers. SCRES can also be improved by enhancing domestic manufacturing capabilities through government assistance programs, skilled workforce development, and interaction with relevant organizations. A thorough re-anchoring program would necessitate a drastic dismantling of the international trade connections and value chains that currently shape the worldwide production of the vast majority of industrial products (Hyppolite 2020). A more flexible, resilient, and responsive manufacturing ecosystem may be produced by routinely assessing the efficacy of reshoring techniques and adjusting in response to shifting market conditions, customer needs, and new hazards.

5.2 Theoretical implications

SCRES theory, relational governance, risk management, contingency planning, and location selection models can all be used to investigate this strategy. Companies may increase their overall resilience and lower the risk of reshoring by putting these ideas into practice. Location decision models, dynamic capacities, creativity, information transmission, and absorptive capacity can all be used to infer theoretical implications. Researchers can enhance SC management and offer insightful analyses about the dynamics and mechanisms driving reshoring methods for establishing SCRES in the electronics manufacturing sector by further exploring these implications.

6 Conclusion

This study examines the role of outsourcing strategies in enhancing supply chain resilience in a rapidly changing global corporate environment. It examines the interactions of various outsourcing approaches, including offshoring, reshoring, nearshoring, and farshoring, to bridge the knowledge gap in global supply chain risk management practices. Reshoring is found to be the most effective strategy for achieving resilience in the manufacturing industry, offering reduced supply chain interruptions, enhanced control, and lower risks. This approach fosters adaptability and responsiveness to evolving situations, reinforcing SCRES. Although specific to the industrial sector, the findings emphasize the importance of considering outsourcing strategies and components in building resilient supply chains across various industries.

Businesses that exploit the opportunities provided by globalization will be able to reach a wider range of consumers, traverse international boundaries, and provide services or commodities to more people, eventually attracting and retaining more customers. GSCs have the capacity to transfer manufacturing and trading shocks from one area to another, but they can also function as a mechanism for lessening the effects of domestic shocks, such as shutdowns, and hasten economic recovery (Chepeliev et al. 2022). Moreover, GSCs can cut costs and increase benefits through trade and tariff incentives, low-cost direct labor, financial subsidies, decreased transportation expenses, easy access to marketplaces, and closeness to suppliers and consumers (Ferdows 1997; MacCormack et al. 1994; Um and Han 2020). Despite the numerous benefits globalizations offers to SCs, it also engenders a significant level of risk with regard to resilience. Outsourcing has emerged as the typical solution to the problems often encountered by companies (e.g., ever-changing SC conditions, risks, disruptions, and increased costs and expenses), and consequently, companies can perform several production and service provision

activities at significantly lower costs, either overseas or by specialized companies in different countries.

This study aimed to analyze and model how different outsourcing strategies interact to equip companies with SCRES. Closing the knowledge gap between the existing understanding and GSC risk management practices was the main objective. Offshoring, reshoring, nearshoring, and farshoring were the four different outsourcing methods examined. In terms of developing resilience in the manufacturing business, each approach has its own benefits and factors that must be considered. According to the analysis, under the current conditions, reshoring is the most viable strategy that will allow the case study company to achieve resilience in the manufacturing industry. Reshoring, which entails moving outsourced activities back to the home nation or area, has several advantages, including fewer interruptions to the SC, better control, and lower risks. This strategy increases awareness of and hastens reactions to evolving situations, thereby strengthening resilience. The efficiency of outsourcing strategies depends on a variety of variables, including the industry, the state of the market, labor prices, the availability of trained workers, infrastructure, and governmental regulations. In particular, with the effects of the COVID-19 pandemic and the integration of new manufacturing technologies, certain production processes (reshoring) from emerging countries could be returned to the home countries of multinational enterprises (MNEs) or to a nearby country in the same region (Pla-Barber et al. 2021).

This study's limitations include its inability to be generalized to other industries, potential contextual biases, poor data quality, outdated findings as a result of outsourcing techniques, and the possibility that it may have overlooked external influences such as geopolitical developments or natural catastrophes. The results may only apply to the industrial industry and may eventually become antiquated.

Future studies can use comparative analysis, case studies, long-term impact analysis, and technical improvements to further explore outsourcing strategies and their effects on SCRES. Further methodological ideas for analyzing outsourcing strategies in SC networks and their effects on diverse sectors include quantitative analysis, simulation modeling, network analysis, and multi-case comparison analysis. Moreover, mathematical modeling or optimization can be developed for finding a solution to more specific questions, such as cost minimization and route

optimization. Other MCDM methods can also be adopted, and the criteria set can be used in other sectors, such as healthcare, fashion, and electronics.

This research explores the crucial role of outsourcing strategies in enhancing supply chain resilience in the dynamic global business landscape. By analyzing and modeling the interplay of various outsourcing approaches, such as offshoring, reshoring, nearshoring, and farshoring, the study aims to bridge the knowledge gap in global supply chain risk management practices. Reshoring is the most effective strategy for achieving resilience in the manufacturing sector, offering reduced disruptions, increased control, and mitigated risks. This strategy also fosters adaptability and responsiveness to evolving scenarios, reinforcing resilience.

Future research should explore the applicability of the findings to diverse industries and the evolving landscape of global trade, including geopolitical developments and natural disasters. Quantitative analysis, simulation modeling, network analysis, and multi-case comparison studies are promising avenues for further research. Mathematical modeling and optimization techniques can be employed to address cost minimization and route optimization within the context of outsourcing. Exploring other MCDM methods and their transferability to sectors like healthcare, fashion, and electronics could further expand the understanding of the relationship between outsourcing and supply chain resilience.

In conclusion, this research lays the groundwork for further exploration of outsourcing strategies as critical tools for enhancing supply chain resilience. By building upon these findings and exploring new territories, researchers can contribute to the ongoing efforts to fortify global supply chains against an ever-evolving landscape of challenges and opportunities.

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