Supplier selection among manufacturing companies based on their MSME partners’ supply chain finance adoption capability using BWM and VIKOR

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Abstract
Purpose — The purpose of this paper is to identify and prioritise supply chain finance (SCF) adoption enablers and develop a novel comprehensive framework to select supplier firms based on their SCF adoption capability.

Design/methodology/approach — The study deploys a three-phase method to identify and prioritise SCF adoption enablers, followed by developing a model to select suppliers according to their SCF adoption capability. An extensive literature review, followed by a Delphi approach-based expert interview, has been used to finalise the enablers. Using the Best Worst Method and the Visekriterijumuško Kompromisno Rangiranje technique, a supplier selection model has been developed in the context of a case company.

Findings — The financial health and technological advancement variables received the top priority, followed by collaborative efficiency, whereas the human resources and organisational variables received the slightest significance. A supplier selection framework has also been developed by using the adoption capability of these factors by the supplier partners. In this study’s model, Supplier 4 exhibited better SCF adoption capability and received the top priority.

Research limitations/implications — Manufacturing supply chains in a developing country are the scope of the current study. Extensive future studies are required to derive a global consensus.

Practical implications — The proposed framework of this study can be used to select supplier firms based on their SCF adoption capability. Policymakers can emphasise the most critical enablers of SCF adoption to assist small supplier firms to be a part of the advanced global supply chains.

Originality/value — The current study established a novel comprehensive framework for supplier selection based on the Supply Chain Finance adoption capability of MSME supplier firms.

Keywords Supply chain finance, SCF, Supplier selection, SCF enablers

Paper type Research paper

Introduction
Micro-, small- and medium-sized enterprises (MSMEs) are one of the primary generators of national and social development on a global scale. Inadequate infrastructure, lack of adequate and expeditious access to capital, lack of technological proficiency, etc., remain obstacles for the SME sector. According to a study by the International Finance Corporation (IFC), 78%, or INR 25.5tn ($510 billion), of the total financing requirement of INR 32.5tn ($650bn) is either self-financed or from informal sources (IFC, 2018). The study also indicates that despite all efforts, a significant funding imbalance of INR 20.9tn ($418bn) still needs to be addressed.

Supply chain finance (SCF) is one of the automated solutions in which the buyer firm provides immediate payment of the supplier firm’s invoices through a financial intermediary. Unlike the factoring process, the SCF programme discounts the supplier bills based on the creditworthiness of the buyer firms, which makes the process faster at less cost (Demicu, 2007; Jongejans et al., 2014). This helps the supplier firms, generally MSMEs with low credit ratings, to get an immediate settlement for their sales to a buying firm. This is significant because it is found that delayed payments are a great concern to MSMEs, which have constrained factoring services to discount their bills (Bose, 2013). Rajaguru et al. (2022) found a sequentially mediating relationship between supply- and demand-oriented performances with SCF and business performance. Studies such as Hofmann et al. (2019), Vu et al. (2022) and Bi et al. (2022) also found that SCF significantly affects supply chain financing and organisational performance. Recent studies also established a relationship between SCF and corporate

Data availability statement: The data that support the findings of this study are available on request from the corresponding author, Aswin Alora. The data are not publicly available due to containing information that could compromise the privacy of research participants.

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sustainability performance (Wang et al., 2023). Factors such as collaboration, digitisation, information sharing and financial institutions enable better SCF adoption, which eventually leads to supply chain effectiveness (Beka Be Nguema et al., 2020).

By realising the benefits of an SCF programme, countries around the world have been adopting various innovative SCF practices and solutions, such as the “SCF scheme” by the UK Government and the Trade Receivables Electronic Discounting System (TReDS) platform by the Reserve Bank of India, enabling faster settlements of the MSME bills. However, lack of funds remains the biggest challenge for MSMEs worldwide (Yan et al., 2017), especially in emerging economies such as India (More and Basu, 2013). Also, it is found that the SCF integration can help the buying firms to reduce their net working capital requirements by an average of 13% (Seifert and Seifert, 2009). However, there is a need for studies that help companies select their supply chain partners based on their SCF adoption capability. This is critical for buying firms to on-board suppliers with higher SCF adoption capability.

From the existing literature, it is evident that the studies extensively focused on understanding the benefits of SCF (Hofmann et al., 2019; Vu et al., 2022; Bi et al., 2022) or exploring the SCF adoption challenges (Garg and Kashav, 2021) or identifying the SCF adoption enablers (Beka Be Nguema et al., 2020; Sahoo and Thakur, 2023) and less on developing comprehensive models which helps buying firms to identify and select supplier partners based on their SCF adoption capability. Even though Wuttke et al. (2013b) tried to identify the reasons for SCF adoption and the role of suppliers in the SCF process through qualitative research work, a gap exists for a comprehensive supplier selection framework. Therefore, this research paper develops a novel framework to assist buying firms in identifying and selecting supplier MSME firms based on their SCF adoption capability in India using a combination of Best Worst Method (BWM) and VIsekriterijumsko Kompromisno Rangiranje (VIKOR) approaches.

Two crucial research questions guide our research work:

- **RQ1.** What are the SCF adoption enablers in MSMEs?

- **RQ2.** How do we frame a model to select supplier MSME firms based on their SCF adoption capability?

The rest of the paper is organised as follows. All relevant and essential studies are depicted in second section. The data collection process and research methodology are presented in the third section. The study shows the analysis and results in fourth section, followed by the conclusion and scope for future research.

**Literature review**

Gelsomino et al. (2016) categorised SCF research based on themes and methodologies for 119 papers published in international peer-reviewed journals between 2000 and 2014. Two perspectives on SCF were outlined in the study: the financial and the supply chain perspectives. Research papers on SCF under both perspectives primarily focus on the enablers, challenges and benefits of SCF adoption. For example, Nguema et al. (2021) explored SCF adoption factors and their impact on manufacturing firms. The research found that SCF positively impacts supply chain effectiveness through information sharing, collaboration and digitalisation. Li et al. (2023) studied how information quantity and information quality influence the relationship between supply chain collaboration and SCF adoption. The results indicate that supply chain collaboration is positively related to SCF adoption.

Studies such as Alora and Barua (2019) and Garg and Kashav (2021) emphasised exploring the SCF adoption barriers by MSMEs in India. Poor financials of the MSME firms and lack of technological sophistication are some of the prime challenges they face in the SCF adoption. This could be why MSME shareholders experience a significant dip in their wealth during supply chain disruptions (Alora and Barua, 2021). Chatnani (2018) analysed the current state of the Reserve Bank of India’s trade receivable exchange platform called TReDS. The central bank rolled out this bill discounting platform for MSME firms in 2017. The study states that similar to global platforms, India, too, faces the challenges of lack of volume and liquidity.

In a more recent study, the impact of SCF on firm performance was empirically studied. According to the study, the SCF significantly reduces supply chain risks and improves organisational performance. The researchers use structural equation modelling (SEM) to test the model based on data from China (Beka Be Nguema et al., 2022). Based on the resource-based view theory, Ali et al. (2018) found that SCF adoption significantly improves MSME performance. Some contemporary works, such as (Moretto and Caniato, 2021), through a focus group study, attempted to understand whether SCF helps mitigate the financial disruption caused by the Covid-19 pandemic. The research stated that the SCF is assisting companies in mitigating financial risks along with improving their environmental and social performance in the short term.

Studies such as Vu et al. (2022) analysed the influence of SCF on SME performance in Vietnam. The results indicate that credit quality, supply chain integration, information exchange, etc., have a significant effect on the performance of SCFs and SMEs. The response of small and medium enterprises in Vietnam to SCF has been measured by Nguyen et al. (2022). According to the results, the SCF has a considerable positive influence on supply chain effectiveness, SME performance and supply chain risk resilience.

More recent studies, such as Supriyanto et al. (2023), investigated the effect of SCF on the profitability of manufacturing firms. The study also stated the significance of the cash conversion cycle on profitability. Chen et al. (2023) found that SCF is vital in supply chain management through functional and structural innovations and helps to solve the capital constraint problems in the agricultural development process. The role of financial intermediaries in facilitating SCF and assisting with financial performance is also explored in the literature. Guo et al. (2023) analysed the e-commerce SCF on MSME financial performance. The results indicate that e-commerce SCF platforms facilitate MSME financing, which helps in financial performance.

There are academic contributions in developing SCF models. Some studies, such as Jiang et al. (2022), developed a trust transitivity model to maximise the value-added and transmission effect of the manufacturing industry chain and alleviate the MSME financing shortage. Another model was developed by Wang et al. (2022), who used machine learning
techniques to predict the credit risk of MSME in SCF. The model was constructed using financial information, operational information, innovation-based information and adverse events. The ratio of operating expenses to operating revenue and net income to business revenue is the most predictive of credit risk.

Various factors that facilitate SCF adoption in suppliers have been recognized based on an extensive literature review of SCF aspects and are discussed below under five categories:

**Financial health-related factors:** Assessing financial health helps understand a supplier’s financial stability and reliability. Credit ratings help assess financial health, and higher credit ratings indicate good financial health (Jongejans et al., 2014; Wuttke et al., 2013a). Firms facing difficulty in availing credit from financial institutions can resort to SCF, and hence, non-availability of credit from financial institutions can be considered a factor (Palia and Sopranzetti, 2004; Tanrisever et al., 2012; Wuttke et al., 2019). Moreover, firms with strong working capital positions, higher costs of financing and lower costs of SCF implementation contribute positively to SCF adoption. Hence, other factors that indicate financial health include strong working capital positions (Hofmann and Kotzab, 2010), higher financing costs (Wuttke et al., 2019) and low implementation costs.

**Technological capability-related factors:** SCF adoption and implementation is driven by technology (Wuttke et al., 2013a; Nguema et al., 2021; Bi et al., 2021). It requires the firms to use third-party platforms for settlements, familiarise themselves with blockchain technology and appoint skilled labour to operate. Hence, technological capability is crucial for the successful adoption of SCF. A recent study (Sahoo and Thakur, 2023) indicates that the variables of “real-time exchange of information” and “transparent platform” have significant influence and play a crucial role in the implementation of blockchain technology in SCF in Indian MSMEs.

On this basis, factors such as a high degree of digitalisation, availability of e-platforms from third parties (Wuttke et al., 2013a) and skilled labour to operate the technology (Haskel and Heden, 1999; Kiley, 1999; Yang and Li (2010), technical capability (Gupta and Barua, 2016; Wuttke et al., 2013a) and blockchain adoption capability (Hofmann et al., 2019; Chen et al., 2021; Jiang et al., 2022) help evaluate the technological competency of firms.

**Human resource-related factors:** Schuler and MacMillan (1984) stated that effective management of human resources is crucial to the growth, prosperity and competitive advantage of an organisation. Randall and Theodore Farris (2009) find that the SCF approach improves trust, commitment and profitability in the supply chain. Hence, a higher level of trust among supply chain partners enables SCF adoption (Kwon and Suh, 2004; Handfield and Bechtel, 2002; Wuttke et al., 2013a, 2013b). The other important factors related to the role of human resource in SCF adoption include commitment of the team (Mentzer et al., 2001; Fawcett et al., 2006), robust relationship with partners (Christopher and Rivals, 1999), shared vision among supply chain partners (More and Basu, 2013), perception of the management towards adoption of SCF (Jongejans et al., 2014) and level of influence of buying firms on supplier firms (Wuttke et al., 2016).

**Organisational factors:** Small firms are likely to adopt SCF faster than larger firms (Wuttke et al., 2019). Hence, firm size facilitates SCF adoption. Secondly, the members of the TReDS platform are more likely to adopt SCF than non-members, making membership of TReDS an influencing factor. Other organisational factors that facilitate SCF adoption include a straightforward job design in the firm (Wuttke et al., 2013b), innovation capability (Chen et al., 2022) and strong risk prevention ability (Zhang, 2015) of the firm.

**Collaborative efficiency-related factors:** Collaboration or cooperation among supply chain partners is essential for the successful adoption and implementation of SCF. Hence, a high level of collaboration among supply chain partners ensures SCF adoption (Kelle and Akbulut, 2005; Bi et al., 2021; Zhang, 2015). Strong cooperation between supply chain partners and smooth facilitation of SCF is also evident when they have shared objectives (More and Basu, 2013), common interest (Viswanathan and Pipiani, 2001), information sharing (Nguema et al., 2021) and good communication between partners (More and Basu, 2013; Wuttke et al., 2013a). Moreover, the awareness of SCF among partners also contributes to SCF adoption (Wuttke et al., 2013a).

A comparative table that shows the previous critical studies on SCF and supplier selection is provided in Table 1.

**Theoretical underpinnings**

We develop our constructs with the help of principal-agent theory and Transaction Cost Theory (TCE). Principal-agent theory sheds light on various problems hindering successful supply chain collaboration, preventing potential improvements (Wandfluh et al., 2016). Principal-agent theory is mainly concerned with two main issues. The first one is concerned with the issues about the conflicts arising from the misunderstanding of the problems between principal and agent. The second issue relates to the understanding of risk sharing and the challenges arising due to the attitude towards risk by the principal and agent. The intensity and experience of these risks vary based on factors such as government policies, competitor actions, economic climate, technological climate, etc. and can lead to uncontrollable variation in outcomes (Eisenhardt, 1989). These issues can also be present in buyer-supplier relationships in supply chains (Lundin and Normann, 2010) and will affect supply chain financial management practices. Authors such as Wandfluh et al. (2016) have applied this theory in depicting the benefits of internal financing in supply chains. Hence, the lens of principal-agent theory is ideal for the base of such a complex model. Based on these theoretical insights, we have considered SCF adoption drivers from a principal-agent perspective in the model. Risks arising from principal-agent relation (buyer-supplier), such as delivery default risk, credit risk, complexity in settlements, cash flow risk and extending trade credit, can also affect the effective adoption of SCF. According to TCE, incorporating information technology in supply chain management improves stakeholder collaboration and reduces coordination costs by increasing supply chain visibility and transparency.

**Research methodology**

This study used a three-phase methodology to evaluate the selection of MSME suppliers based on their SCF adoption capability (see Figure 1). This three-step methodology’s objective is to conclude the selection criteria for MSME
Table 1 Comparative table on previous studies on SCF and supplier selection

<table>
<thead>
<tr>
<th>Author</th>
<th>Key findings</th>
<th>Methodology used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bi et al. (2022)</td>
<td>SCF helps in mitigating supply chain risks and thereby improving organizational performance</td>
<td>Partial least squares-based SEM</td>
</tr>
<tr>
<td>Wanget al. (2023)</td>
<td>SCF affects corporate sustainability performance. Corporate financial performance is also found to promote the positive effect of SCF and environmental, social and governance performance</td>
<td>Fuzzy-set qualitative comparative analysis</td>
</tr>
<tr>
<td>Beka Be Nguema et al. (2020)</td>
<td>Information sharing, digitization and financial institutions, external collaboration helps to mitigate firm risk and thereby enhancing the supply chain effectiveness</td>
<td>Structural equation modelling</td>
</tr>
<tr>
<td>Soni et al. (2022)</td>
<td>Developed a hesitant fuzzy-based technology selection framework to determine the most suitable Industry 4.0 technology for sustainable supply chain finance</td>
<td>Hesitant fuzzy-based technology selection framework</td>
</tr>
<tr>
<td>Afrasiabi et al. (2022)</td>
<td>16 economic, environmental, social, or resilient assessment factors are listed. According to the case study, “pollution control,” “environmental management system” and “risk awareness” are the most important factors for researching manufacturing-related sustainable-resilient supplier selection problems</td>
<td>Fuzzy BWM and TOPSIS</td>
</tr>
<tr>
<td>Chen et al. (2020)</td>
<td>Developed a model to identify smart-sustainable supply chain management practices as supplier selection criteria for a smart supply chain</td>
<td>DEMATEL-TOPSIS</td>
</tr>
<tr>
<td>Jia et al. (2020)</td>
<td>Created an integrated conceptual framework to show how SCF providers manage risks, build capabilities and connect the financial supply chain (SC)</td>
<td>Literature review-based conceptual approach</td>
</tr>
<tr>
<td>Lekkakos and Serrano (2016)</td>
<td>Model a supplier’s inventory replenishment problem as a multi-stage dynamic program and derive the supplier’s optimal inventory policy</td>
<td>Multi-stage dynamic program</td>
</tr>
<tr>
<td>Ma et al. (2020)</td>
<td>Top management support, trust and IT infrastructure are the factors considered the most important by financial service providers in SCF</td>
<td>Interpretive structural modelling</td>
</tr>
<tr>
<td>Pamucar et al. (2022)</td>
<td>Job creation and occupational health and safety systems are two top criteria during supplier selection in health-care supply chain management during the Covid-19 pandemic. The supplier selection model is also developed using MACBETH method</td>
<td>Measuring attractiveness through a categorical-based evaluation technique (MACBETH)</td>
</tr>
<tr>
<td>Tong et al. (2022)</td>
<td>Developed a sustainable supplier selection evaluation framework. Cost, credit and corporate irregularities are the vital aspects for MSMEs to evaluate supplier performance</td>
<td>Extended PROMETHEE II method</td>
</tr>
<tr>
<td>Wuttke et al. (2013a, 2013b)</td>
<td>A framework is proposed for the interrelated innovation adoption processes of buying firms and their supplier firms in SCF</td>
<td>Multiple case study approach; conceptual approach</td>
</tr>
<tr>
<td>Wuttke et al. (2019)</td>
<td>Suppliers with less financing implement SCF sooner. Suppliers also finance faster if it reduces their finance costs more</td>
<td>Cox proportional hazard rate model with buyer fixed effects</td>
</tr>
<tr>
<td>Current study</td>
<td>Developed a novel comprehensive framework to select supplier firms based on their SCF adoption capability</td>
<td>BWM and the VIKOR technique</td>
</tr>
</tbody>
</table>

Source: Authors’ own work

suppliers by using a mix of expert opinion, quantitative analysis and a review of the relevant literature. Following the completion of the first step, which involves the identification of the assessment criteria using exhaustive research of the pertinent literature, the second phase consists of finalising these criteria using a panel discussion with industry professionals using the Delphi technique. The third phase uses BWM to rank the evaluation criteria for the SCF adoption capabilities of MSMEs. It uses the VIKOR approach to evaluate the performance of selected enterprises based on these criteria.

The Delphi technique is a structured and systematic approach within multi-criteria decision making (MCDM) used to collect input and insights from a panel of experts, enabling the attainment of consensus or well-informed decisions in complex and uncertain scenarios. MCDM pertains to assessing and contrasting multiple criteria or attributes to facilitate informed decision-making. This method is particularly advantageous when a single decision maker or a straightforward voting process may prove insufficient, given the intricacies and potential subjectivity inherent in the issue.

In the context of data collection, Delphi techniques were used to identify barriers and devise strategies to overcome them. The Delphi technique is chosen for its structured communication approach. It facilitates soliciting expert opinions from a group of individuals, typically aimed at making informed decisions or predictions regarding a specific topic or issue (Ahmad and Wong, 2019). The procedure entails a sequence of questionnaires or surveys distributed to a panel of experts who provide their opinions and feedback anonymously. Typically, the process involves a facilitator identifying a group of experts within a specific field or industry. The facilitator subsequently distributes a series of questionnaires or surveys to
these experts, requesting their input on a particular topic or issue. The responses are then collated and analysed by the facilitator, who may offer feedback to the experts in subsequent rounds of inquiry. The Delphi technique’s design is geared towards reducing bias and diminishing the influence of dominant or vocal individuals within the group (Kumar et al., 2020; Kusi-Sarpong et al., 2023).

The primary and sub-attributes finalised are given in Table 2.

The BWM, developed by Jafar Rezaei in 2015, is a MCDM technique used to assess and rank alternatives based on their performance against a set of criteria. It is beneficial when decision-makers must determine which choices are the best and worst among a group of options (Rezaei, 2015, 2016). The BWM helps assign weights to criteria and subsequently prioritise the alternatives. The process involves selecting the best and worst alternatives for each criterion and then calculating scores for each alternative. These scores can be used to rank the alternatives. In our study, we adopted the BWM to assess the relative importance of criteria in our decision-making process and to determine the best and worst criteria, calculate weight scores, and rank criteria based on their significance. The BWM enables us to prioritise the criteria effectively, contributing to the robustness of our decision-making framework.

The VIKOR method is another MCDM technique used to rank alternatives with conflicting criteria (Shumaiza et al., 2019). It works on compromise programming, which makes this technique better than other techniques. The VIKOR method is a compromise priority approach helpful in

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**Figure 1** Schematic for phases of methodology

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**Source:** Authors own work
optimising multiple responses. It is based on a multi-attribute ranking index obtained from the comparison of the closeness of each attribute to the ideal alternative (Garg and Sharma, 2020). VIKOR is preferred in alternative selection as compared to other MCDMs, i.e. TOPSIS, ANP, ELECTRE, etc. because it measures closeness to a positive ideal solution, which reduces the risk in decision-making and optimises the decision maker’s choice (Liang et al., 2021). The VIKOR is particularly useful for ranking alternatives, as it is based on a multi-attribute ranking index obtained from the comparison of the closeness of each attribute to the ideal alternative (Garg and Sharma, 2020). VIKOR is preferred in alternative selection as compared to other MCDMs, i.e. TOPSIS, ANP, ELECTRE, etc. because it measures closeness to a positive ideal solution, which reduces the risk in decision-making and optimises the decision maker’s choice (Liang et al., 2021). The VIKOR is particularly useful
when decision-makers seek a balance between the best and worst-case scenarios while considering multiple criteria. Moreover, the VIKOR approach chooses the best alternative with accuracy and optimises the results.

The following are some of the stages.

**Finalisation of supply chain finance adoption criteria and determination of micro-small and medium-sized enterprises’ supply chain finance adoption capabilities using Best Worst Method**

Using a combination of literature review, the Delphi method and a panel discussion, the enablers for SCF adoption in MSMEs have been finalised. BWM is a highly effective MCDM technique used by numerous researchers.

The stages outlined by Rezaei (2016) and Rezaei et al. (2016) are described in detail below.

Step one is the selection of attributes for analysis based on a review of the relevant literature and expert opinion, as shown in Table 2. In step two, attributes have been classified as best and worst variables with the help of experts. Step three consisted of requesting from each expert a preference rating on a scale from 1 to 9, as shown in Table 3. Step four involved the experts providing a preference rating for each attribute relative to the worst attribute. Step 5 involved calculating the optimised weights \( w_1, w_2, \ldots, w_n \) for each attribute. The profile of the respondents is given in Table 4.

The purpose of this study is to determine attribute weights that minimise the utmost absolute differences for all \( j \) can be minimised for \(|w_B - a_{Bj}w_j|, |w_j - a_ww_j|\}. The subsequent minimax model turns out to be:

\[
\min \max \left\{ |w_B - a_{Bj}w_j|, |w_j - a_ww_j| \right\} \quad \text{s.t. } \sum_j w_j = 1, w_j \geq 0, \text{ for all } j
\]  

(1)

Model (1) converted into a linear model yields superior results; the resulting model is depicted below.

\[
\min \xi^L \\
\text{s.t. } |w_B - a_{Bj}w_j| \leq \xi^L, \text{ for all } j \\
|w_j - a_ww_j| \leq \xi^L, \text{ for all } j \\
\sum_j w_j = 1 \\
w_j \geq 0, \text{ for all } j
\]  

(2)

Model (2) may be resolved for optimised weights \( w_1^+, w_2^+, \ldots, w_n^+ \) and optimal value \( \xi^L \).

Consistency (\( \xi^L \)) of attribute comparisons close to 0 is desired (Rezaei, 2016).

**Ranking the alternatives using VIskriterijumsko Kompromisno Rangiranje**

The steps of the VIKOR methodology are discussed below:

**Step 1:** Using Table 5’s scale, a pairwise matrix of criteria and options was essential.

**Step 2:** By using equation (3), the average decision matrix is developed as follows:

\[
F = \frac{1}{k} \sum_{k=1}^{k} F_k
\]  

(3)

Where \( k \) is decision makers, and \( F \) is the average decision matrix.

**Step 3:** By using formulas (4) and (5), the best \( f_b^+ \) and the worst \( f_b^- \) values of all the criteria, \( b = 1, 2, \ldots, n \) is computed:

\[
f_b^+ = \max (f_{ab})
\]  

(4)

\[
f_b^- = \min (f_{ab})
\]  

(5)

where \( f_b^+ \) is the positive ideal solution and \( f_b^- \) is the negative ideal solution for the \( b \) attribute.

**Step 4:** Compute the \( S_b \) and \( R_a \) values for \( a = 1, 2, \ldots, m \) using equations (6) and (7):

**Table 5** Linguistic scale for pairwise comparison for VIKOR methodology

<table>
<thead>
<tr>
<th>Scale of BWM</th>
<th>Importance rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least important</td>
<td>1</td>
</tr>
<tr>
<td>Moderately important</td>
<td>2</td>
</tr>
<tr>
<td>Strongly important</td>
<td>3</td>
</tr>
<tr>
<td>Very strongly important</td>
<td>4</td>
</tr>
<tr>
<td>Extremely important</td>
<td>5</td>
</tr>
</tbody>
</table>

**Source:** Authors’ own work

**Table 4** Profile of the experts

<table>
<thead>
<tr>
<th>Relevant dimension</th>
<th>Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job positions of the respondents</td>
<td>16% senior level</td>
</tr>
<tr>
<td></td>
<td>63% middle level</td>
</tr>
<tr>
<td></td>
<td>21% lower level</td>
</tr>
<tr>
<td>Qualification of respondents</td>
<td>32% postgraduate</td>
</tr>
<tr>
<td></td>
<td>42% undergraduate</td>
</tr>
<tr>
<td></td>
<td>26% diploma</td>
</tr>
<tr>
<td>Experience of respondents (years)</td>
<td>16% &gt; 11</td>
</tr>
<tr>
<td></td>
<td>31% &gt; between 5 and 10</td>
</tr>
<tr>
<td></td>
<td>53% &lt; 5</td>
</tr>
</tbody>
</table>

**Source:** Authors’ own work

**Table 3** Linguistic scale for pairwise comparison for best worst methodology

<table>
<thead>
<tr>
<th>Importance rating</th>
<th>Equally important</th>
<th>Equal to moderately important</th>
<th>Moderately more important</th>
<th>Moderately to strongly more important</th>
<th>Strongly more important</th>
<th>Strongly to very strongly more important</th>
<th>Very strongly more important</th>
<th>Very strongly to extremely more important</th>
<th>Extremely more important</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

**Source:** Authors’ own work
equation (8), the scores for $Ra$ are computed as follows:

$$S_a = \sum_{b=1}^{n} W_b \left[ \left( f_b^a - f_{ab} \right) / \left( f_b^a - f_b^a \right) \right]$$  \hspace{1cm} (6)$$

$$R_a = \text{Max}_b \left[ W_b \left( f_b^a - f_{ab} \right) / \left( f_b^a - f_b^a \right) \right]$$  \hspace{1cm} (7)$$

The solution provided by $S_a$ and $R_a$ are based on the value maximum group utility (majority rule) and minimum individual regret of the opponent, respectively, and $W_b$ depicts the weights of the criteria as stated by Ebrahminnejad et al. (2012).

**Step 5:** By using equation (8), the scores for $Q_a$ were computed as follows:

$$Q_a = v \left( S_a - S^* \right) / (S^* - S^*) + (1 - v) \left( R_a - R^* \right) / (R^* - R^*)$$  \hspace{1cm} (8)$$

Where, $S^* = \text{Max}_a S_a, S = \text{Min}_a S_a, R^* = \text{Max}_a R_a, R = \text{Min}_a R_a$ and $v$ depicts the weight of the strategy of “the majority of criteria” (or the maximum group utility), where $v = 0.5$. This solution is stable within a decision-making process, which could be: “voting by majority rule” (when $v > 0.5$ is needed) or “by consensus” $v = 0.5,$ or “with veto” ($v < 0.5$) (Opricovic and Tzeng, 2004; Sanayei et al., 2010). $Q_a$ denotes VIKOR index.

**Step 6:** By using $Q_a$ values, the ranking of the alternatives is done.

**Step 7:** The ranking of the alternatives is carried based on the minimum $Q_a$ values obtained by the below simultaneously satisfying two conditions:

1. Condition 1: $Q(A(1))$ is chosen if $Q(A(2)) - Q(A(1)) \geq 1/ n - 1$, where $A(1)$ is the alternative that has the second rank in the analysis and $n$ is the total alternatives.
2. Condition 2: $Q(A(1))$ also obtains the first rank according to both $S_a$ and $R_a$ values.

**Step 8:** Alternatively, the obtained minimum score in $Q_a$ is ranked first.

**Case analysis and application using the proposed methodology**

This research study analyses the Indian manufacturing industrial sector. This study analysed five MSME OEM suppliers of a major Indian automobile company to determine the optimum MSME supplier based on SCF adoption. The panel consensus method was used to gather expert data. Table 3 shows the scales the five experts used to rate the MSME attributes for BWM. Table 5 shows the scale for pairwise comparison for VIKOR. Expert 1 is a managing director and CEO of a renowned automotive company with over 35 years of industry experience. Expert 2 and Expert 3 are Executive Vice Chairman and Executive Managing Director of an Automotive manufacturing company with over 15 years of industry expertise. Expert 4 is the branch manager of a bank who specialises in bills discounting of the corporates. Expert 5 is an entrepreneur of a small-scale business which manufactures OEM components for automotive companies. We sought the assistance of another ten experts to validate the results, which accounts for the total number of experts involved in the study to fifteen.

**Finalisation of attributes of supply chain finance adoption capability**

The extensive literature review and expert interview resulted in 5 categories of variables and 27 sub-attributes of SCF adoption capabilities in MSMEs.

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**Table 6** Weights and ranking of main and sub-attributes

<table>
<thead>
<tr>
<th>Broad criteria</th>
<th>Weight</th>
<th>Code</th>
<th>Weight</th>
<th>Global weight</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial health (1)</td>
<td>0.290</td>
<td>F1</td>
<td>0.184</td>
<td>0.053</td>
<td>10</td>
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<tr>
<td></td>
<td>0.290</td>
<td>F2</td>
<td>0.217</td>
<td>0.063</td>
<td>4</td>
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<tr>
<td></td>
<td>0.290</td>
<td>F3</td>
<td>0.218</td>
<td>0.063</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>0.290</td>
<td>F4</td>
<td>0.087</td>
<td>0.025</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>0.290</td>
<td>F5</td>
<td>0.295</td>
<td>0.085</td>
<td>1</td>
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<tr>
<td>Technological capability (2)</td>
<td>0.180</td>
<td>T1</td>
<td>0.341</td>
<td>0.061</td>
<td>5</td>
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<td>0.180</td>
<td>T2</td>
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<td>T5</td>
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<td>0.013</td>
<td>23</td>
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<tr>
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<td>0.072</td>
<td>H2</td>
<td>0.193</td>
<td>0.014</td>
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<tr>
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<td>0.072</td>
<td>H4</td>
<td>0.244</td>
<td>0.018</td>
<td>19</td>
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<tr>
<td></td>
<td>0.072</td>
<td>H5</td>
<td>0.075</td>
<td>0.005</td>
<td>27</td>
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<td></td>
<td>0.072</td>
<td>H6</td>
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<td>0.007</td>
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<tr>
<td></td>
<td>0.239</td>
<td>O4</td>
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<td>0.055</td>
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<td>0.015</td>
<td>20</td>
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<td>0.053</td>
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</tr>
<tr>
<td></td>
<td>0.219</td>
<td>C2</td>
<td>0.101</td>
<td>0.022</td>
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</tr>
<tr>
<td></td>
<td>0.219</td>
<td>C3</td>
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<td>0.044</td>
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<tr>
<td></td>
<td>0.219</td>
<td>C4</td>
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<tr>
<td></td>
<td>0.219</td>
<td>C5</td>
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<td>0.061</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>0.219</td>
<td>C6</td>
<td>0.056</td>
<td>0.012</td>
<td>24</td>
</tr>
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</table>

Source: Authors’ own work
## Table 7: Average rating of 8 experts

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>H1</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
<th>H5</th>
<th>H6</th>
<th>O1</th>
<th>O2</th>
<th>O3</th>
<th>O4</th>
<th>O5</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
</tr>
</thead>
</table>

Source: Authors own work
Table 8  Weighted average

| Suppliers | F1   | F2   | F3   | F4   | F5   | T1   | T2   | T3   | T4   | T5   | H1   | H2   | H3   | H4   | H5   | H6   | O1   | O2   | O3   | O4   | O5   | C1   | C2   | C3   | C4   | C5   | C6   |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| S1        | 0.019| 0.037| 0.000| 0.025| 0.000| 0.061| 0.000| 0.003| 0.017| 0.000| 0.005| 0.014| 0.000| 0.000| 0.002| 0.007| 0.000| 0.012| 0.064| 0.051| 0.015| 0.027| 0.000| 0.010| 0.009| 0.008|
| S2        | 0.042| 0.052| 0.000| 0.022| 0.085| 0.000| 0.046| 0.000| 0.022| 0.000| 0.013| 0.004| 0.015| 0.014| 0.004| 0.003| 0.033| 0.000| 0.038| 0.034| 0.008| 0.015| 0.022| 0.037| 0.009| 0.010|
| S3        | 0.011| 0.026| 0.063| 0.006| 0.085| 0.049| 0.055| 0.010| 0.005| 0.016| 0.002| 0.008| 0.007| 0.018| 0.005| 0.005| 0.053| 0.052| 0.051| 0.055| 0.008| 0.013| 0.019| 0.022| 0.026| 0.052| 0.009|
| S4        | 0.000| 0.000| 0.000| 0.000| 0.043| 0.012| 0.028| 0.007| 0.000| 0.032| 0.004| 0.009| 0.000| 0.004| 0.000| 0.000| 0.018| 0.000| 0.000| 0.000| 0.000| 0.000| 0.022| 0.000| 0.021| 0.061| 0.000|
| S5        | 0.053| 0.063| 0.028| 0.016| 0.000| 0.037| 0.018| 0.004| 0.007| 0.000| 0.000| 0.000| 0.000| 0.000| 0.000| 0.000| 0.004| 0.005| 0.003| 0.013| 0.016| 0.025| 0.034| 0.008| 0.033| 0.014| 0.026| 0.000| 0.000| 0.012|

Source: Authors’ own work
Supplier selection among manufacturing companies
Arsen Alora and Himanshu Gupta

Table 9 The S, Q and R values and ranking of suppliers

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>S</th>
<th>Rank</th>
<th>R</th>
<th>Rank</th>
<th>Q</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>0.429</td>
<td>3</td>
<td>0.064</td>
<td>3</td>
<td>0.243</td>
<td>3</td>
</tr>
<tr>
<td>S2</td>
<td>0.578</td>
<td>4</td>
<td>0.085</td>
<td>4</td>
<td>0.836</td>
<td>4</td>
</tr>
<tr>
<td>S3</td>
<td>0.734</td>
<td>5</td>
<td>0.085</td>
<td>5</td>
<td>1.000</td>
<td>5</td>
</tr>
<tr>
<td>S4</td>
<td>0.259</td>
<td>1</td>
<td>0.061</td>
<td>1</td>
<td>0.000</td>
<td>1</td>
</tr>
<tr>
<td>S5</td>
<td>0.428</td>
<td>2</td>
<td>0.063</td>
<td>2</td>
<td>0.227</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Authors’ own work

Discussion of results

The present study uses the BWM to prioritise the assessment criteria for the SCF adoption capabilities of MSMEs. The Delphi technique is used to gather information and perspectives from a group of experts for the study. Additionally, the study uses the VIKOR technique to assess the performance of the chosen supplier businesses, considering the evaluation as mentioned in the above criteria. The financial health of an organisation has received the highest weight (0.290) and, as a result, the first rank among the five primary SCF adoption facilitators. The term “financial health” refers to various factors, including more substantial credit ratings, solid working capital balances, higher financing costs, etc. Because the financial capability of a supplier company will play a direct deciding role in the adoption of advanced technology, innovations, risk prevention and mitigation ability, which will lead to higher adoption of SCF, it is evident that the financial enablers are found to be the significant SCF adoption enabler. The significance of financial capabilities is emphasised in the previous research as well (Wagner, Bode and Koziol, 2009; Wetzel and Hofmann, 2019; Alora and Barua, 2019). Therefore, the current study aligns with the existing literature on the importance of financial aspects of SCF. Financial capabilities are also found to be a critical factor in selecting socially responsible suppliers in the banking industry in earlier studies (Ojadian et al., 2023). Under the five subcategories, Low implementation cost (F5) received the first place, followed by solid working capital positions (F3), non-availability of credit from financial institutions (F2), higher credit ratings (F1) and higher financing costs (F4).

Industry 4.0 technologies, such as the Internet of Things, big data, cloud computing, are vital in SCF adoption in MSMEs (Soni et al., 2022). The capacity for technological advancement (0.180) was awarded second place among the primary factors. Based on the tenets of TCE, the primary objective of using information technology within supply chain management is to enhance collaboration among supply chain stakeholders and mitigate coordination costs by augmenting supply chain visibility and transparency. Technology will make it possible for businesses to transact their bills and receive discounts from a variety of partners in a systematic manner. The vast majority of bill discounting in India occurs on the TRedS platform, which the country’s central bank controls. When it comes to registering, listing bills and conducting business among the intermediaries, technology plays an essential role. Hence, the present study’s findings assert that the technology adoption capabilities of supplier firms play a crucial role in facilitating SCF implementation, potentially leading to a reduction in transaction costs (TCE) and an enhancement in corporate performance (Subrahmanyam, 2011).

The sub-attributes under technological advancement were ranked as follows: High degree of digitalisation (T1), Availability of E-platforms from 3rd parties (T2), Blockchain adoption capability (T3), Technological capability (T4) and Availability of skilled labour to operate technology (T5). The availability of digital SCF platforms was not considered in the literature (Soni et al., 2022; Wu and Zhang, 2022; Li et al., 2023). However, the results of the current study depict the significance of this in easier SCF adoption, as this received the second ranking among the sub-categories of the capacity for technological advancement variable.

The significance of collaboration is evident in the SCF literature (Li et al., 2023; Laorden et al., 2022; Bek Be Nguema et al., 2020). Collaborative efficiency comes in at number three on the list of critically significant enablers for SCF adoption (0.219) in the current study. Collaboration between financial institutions and suppliers is essential for successful SCF, as SCF focuses on a collaborative inter-organizational financing approach (Ma, Wang and Chan, 2020). Communication and settlements must take place on a timely basis for SCF programmes. The level of awareness on SCF (C5), which rates best among the subcategories of collaboration, is followed by Cooperation among partners (C1), Common interest among partners (C3), Good communication between partners (C4), Shared objective among partners (C2) and Higher level of information sharing (C6).

Regarding the primary criteria, the human resource factors and the organisational factors come in at positions four and five, respectively. The authors believe these factors are also crucial for seamless SCF adoption. Top management support and trust among the supply chain partners are critical SCF enablers in the past research (Ma et al., 2020).

The adoption drivers of SCF have been examined in our model from a principal-agent approach. Many risks can hinder the successful adoption of SCF from the principal-agent relationship between buyers and suppliers. As the results indicate, these risks can come mainly from a lack of cooperation among supply chain partners, lack of common interest among the supply chain partners, poor communication between the supply chain partners, lack of integrated technology among the partners, and poor credit ratings of the buyer firms.

Following the assessment of the factors facilitating the adoption of SCF, a subset of suppliers was chosen and then evaluated using the VIKOR approach based on the established criteria. The suppliers have been rated in the following manner: S4 > S5 > S1 > S2 > S3. The findings suggest that Supplier 4 (S4) has the highest level of capacity in adopting SCF. The managers of the other supplier businesses can emulate the characteristics of S4 to enhance their efficiency in adopting SCF and meet the expectations of their buying firms.

Conclusions and scope for future research

Persistent economic downturns and financially constrained supply networks paved the door for SCF solutions. SCF adoption is expected to improve the cash flows, reduce the cost of capital and improve the relationships between supply chain partners. Most of the supplier firms in developing countries such as India are MSMEs, which need more capabilities of better SCF adoption, such as better financials, technological capabilities, collaborative efficiency, human resources and organisational capabilities. Therefore, in this study, an
innovative and comprehensive framework for buying companies to select suppliers based on their SCF adoption capabilities was simulated. The research focused on five original equipment manufacturers that supply a prominent Indian vehicle manufacturer. A comprehensive assessment of the relevant literature uncovered 5 main SCF enablers and 27 sub-enablers in the first phase. The next step consisted of finalising the SCF adoption enablers by conducting expert interviews using the Delphi method. Finally, the BWM and the VIKOR were used in the process of ranking these enablers of SCF adoption and selecting the best suppliers based on these criteria.

According to the findings of the analysis, the element of financial health was given the highest importance, followed by the factor of technological capability, collaborative efficiency, the human resource factor and the organisational factors. MSMEs typically have supply chains that are financially constrained and lack technological capabilities. By prioritising the above factors and their sub-factors, supply chain partners can effectively adopt SCF, which can reduce default risk, access short-term capital, minimise settlement complexity and improve cash flows. These findings may inspire policymakers and managers to provide the necessary attention to these areas in the future, which will assist small- and medium-sized enterprise suppliers adopt SCF more expediently. A similar hypothesis could be tested in subsequent studies involving various types of businesses or geographic regions. In addition, more sophisticated methods such as regression, ANOVA, SEM or DEMATEL could be used in future research to validate the findings obtained.

Implications of the study
The current study developed a novel comprehensive framework to select supplier firms based on their SCF adoption capability. The integrated BWM and VIKOR analysis highlight the following implications: A framework to evaluate suppliers of commonality but not necessarily their relative significance.

The managers could make use of the developed model and investigate the areas in which their company faces difficulties and work to improve those areas to accommodate the growing needs of their buying partners and to participate in a variety of SCF programmes. This framework can help these companies enhance their financial and technological capabilities, which will, in turn, enable them to take advantage of possibilities in more competitive business environments. Factors such as low cost, more vital working capital positions, good credit ratings, the level of digitalisation are found to be critical enablers in SCF adoption. The managers can try to advance on these parameters to facilitate seamless SCF adoption and benefit.

References


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Further reading


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