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Optimizing Textile Supply Chains: Vendor Selection Using the DEMATEL Approach

Dr S N Arjun Kumar[1], Mrs.C.Kartheeswari[2], Ms. Nandhini M[3], R. C. Thivyarathi[4], Dr V.T Dhanaraj[5],V.Mano Priya[6]
[1]*Assistant professor, Department of Business management, University PG college, Palamuru University, Mahabubnagar*
[2]*Assistant Professor, Department of Mathematics, Seethalakshmi Achi college for women,Pallathur, Karaikudi ,Sivagangai District*
[3]*Assistant Professor, Department of Mathematics, Dr. G. R. Damodaran College of Science, Coimbatore*
[4]*Assistant Professor, Department of Science and Humanities,R. M. K college of engineering and technology,Pudhuvoyal*
.[5]*Associate Professor & Head, Department of Commerce -Rathinam College of Arts & Science (Autonomous), Coimbatore, Tamil Nadu, India*
[6]*Assistant professor, Department of Commerce, United College of Arts and Science, Coimbatore*

Abstract: ***This study investigates the use of the Decision Making Trial and Evaluation Laboratory (DEMATEL) method to evaluate and rank key criteria in supplier selection for the textile industry in the Erode district. A validated questionnaire, reviewed by experts with over 40 years of industry experience, was used to perform pairwise comparisons among four critical criteria: Company Profile (C1), Quality (C2), Cost (C3), and Delivery (C4). The DEMATEL results indicate that Delivery (C4) is the most influential criterion, securing the highest Q+R score (7.7128), followed by Company Profile (C1) with a Q+R value of 5.3678. In terms of net influence, Quality (C3) ranks first with a Q−R score of 2.3857, highlighting its strong impact on other factors. These findings demonstrate that timely delivery and consistent quality are essential for effective supplier performance. By uncovering the interdependencies between criteria, DEMATEL offers a structured, data-driven approach to support decision-making and enhance supply chain optimization in uncertain and dynamic environments.***
Keywords: Supply Chain Management, Textile Industry, DEMATEL, Decision-Making

I. INTRODUCTION

In today's highly competitive and globalized business environment, effective supply chain management (SCM) has become a critical factor in determining a company's success. The ability to deliver products and services efficiently, reliably, and at competitive costs requires seamless coordination among all components of the supply chain. As businesses face increasing pressure to enhance customer satisfaction, reduce costs, and respond quickly to market changes, the role of SCM continues to grow in strategic importance.Supply chain management involves the planning, execution, and control of all activities related to sourcing, procurement, production, and logistics. Its primary goals are to reduce risks, improve organizational performance, and increase overall profitability. In this context, suppliers play a vital role in ensuring a consistent and quality flow of materials and services. The effectiveness of a supply chain is heavily dependent on the reliability and performance of its suppliers, making supplier selection a strategic priority for companies aiming to achieve operational excellence.Selecting the right supplier is not merely a routine procurement task; it is a critical decision that can significantly influence the efficiency, cost-effectiveness, and resilience of the supply chain. A poor supplier choice can lead to disruptions, delays, and increased costs, while the right supplier partnership can foster innovation, improve quality, and reduce risks. Therefore, understanding the importance of supplier selection within the broader framework of supply chain management is essential for businesses striving to build strong and sustainable operations.The Decision Making Trial and Evaluation Laboratory (DEMATEL) method has been instrumental in addressing complex decision-making problems by analyzing and visualizing the structure of causal relationships among factors. In the context of supplier selection, DEMATEL aids in identifying interdependencies among evaluation criteria, enabling a more informed and holistic decision-making process.

II. LITERATURE REVIEW

AHP has been extensively applied in the textile industry for supplier evaluation. For instance, Muralidharan et al. (2002) utilized AHP to assess suppliers based on quality, delivery, and cost criteria. Similarly, Chan (2003) employed AHP to develop an interactive selection model for supplier evaluation. TOPSIS has been used to rank suppliers by calculating the geometric distance between each alternative and the ideal solution.

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For example, Ghodsypour and O'Brien (2001) combined AHP and TOPSIS to select suppliers in the textile industry, considering both qualitative and quantitative factors. VIKOR has been applied to find compromise solutions in supplier selection. For instance, Sanayei et al. (2008) integrated VIKOR with AHP to evaluate suppliers in the textile sector, balancing multiple criteria to arrive at a consensus decision. Comparative analyses have been conducted to determine the effectiveness of various MCDM methods. For example, Dulmin and Mininno (2003) compared AHP and ELECTRE methods in supplier selection, highlighting the strengths and limitations of each approach. Initial applications of DEMATEL in supplier selection were often combined with other Multi-Criteria Decision Making (MCDM) methods to enhance decision accuracy. For instance, Büyüközkan and Çifçi (2012) integrated fuzzy DEMATEL with fuzzy Analytic Network Process (ANP) and fuzzy TOPSIS to evaluate green suppliers, demonstrating the method's effectiveness in handling uncertainty and interrelated criteria. Similarly, Abdel-Basset et al. (2018) proposed a hybrid approach combining neutrosophic sets with DEMATEL to develop supplier selection criteria, addressing the ambiguity and uncertainty inherent in expert judgments. Specific to the textile industry, Li et al. (2019) applied the DEMATEL approach to analyze the interrelationships among supplier selection criteria in Chinese textile industries, focusing on leagile supply chain strategies.Building upon this, Utama et al. (2021) conducted a case study integrating DEMATEL and ANP for supplier selection in the textile industry, highlighting the importance of considering both the interdependencies among criteria and their relative weights. Furthermore, Chakraborty et al. (2018) utilized an integrated DEMATEL–VIKOR method for cotton fiber selection and evaluation, demonstrating the applicability of DEMATEL in assessing material quality in textile manufacturing. Recent studies have explored hybrid models combining DEMATEL with other MCDM techniques to enhance supplier selection processes. For example, Chen et al. (2020) proposed a sustainable supplier selection model integrating rough DEMATEL and fuzzy VIKOR methods, addressing both the interrelationships among criteria and the uncertainty in expert evaluations. Additionally, a study by Büyüközkan and Güleryüz (2016) applied an integrated DEMATEL-ANP approach for renewable energy resource selection, which, while not specific to textiles, provides a methodological framework applicable to supplier selection in various industries.

III. CONTRIBUTION

This study aims to integrate the Decision Making Trial and Evaluation Laboratory (DEMATEL) method to support supplier selection in the textile industry. The DEMATEL approach is employed to analyze and quantify the interrelationships and influence among selection criteria, enabling a deeper understanding of their causal interactions.

IV. PROPOSED DECISION MAKING TRIAL AND EVALUATION LABORATORY (DEMATEL)

The proposed method decision-making trial and evaluation laboratory (DEMATEL) method are discussed

Algorithm

1) Direct-Relation Matrix (Z): Experts evaluate the direct influence of one factor on another using a scale (commonly 0–4 or 0–5, where 0 = no influence and 4/5 = very strong influence).

2) Normalization: The direct-relation matrix is normalized to scale all influences between 0 and 1.

3) Total Relation Matrix (T):

T=Z(I−Z)−1T = Z (I - Z)^{-1}T=Z(I−Z)−1

This captures both direct and indirect influences among factors.

4) Prominence (D + R):

- DDD: sum of rows = influence given (how much a factor affects others)
- RRR: sum of columns = influence received (how much a factor is affected by others)
- D+RD + RD+R: total importance or prominence

5) Relation (D - R):

- Positive D−RD - RD−R: Cause group (driving factors)
- Negative D−RD - RD−R: Effect group (outcomes)

V. CASE STUDY

The numerical experimental data was collected from one place such that Erode. After that, the questionnaire was reviewed by the Experts more than 40 years' textile industries experience and to make the pairwise comparison of the matrix. This study considered the various types of criteria such as Company Profile (C1), Quality (C2), Cost (C3), and Delivery (C4). The above criteria we considered to determine the weight of the criteria by using DEMATEL. The DEMATEL value are shows in Table 1.

VI. RESULTS AND DISCUSSION

Table 1:The comparative DEMATEL technique Q+R and Q−R value

Criteria	S+R	Rank	S-R		Rank
C_1	5.3678	2	C_1	-0.4040	3
C_2	3.5549	3	C_2	-0.7711	2
C_3	2.5123	4	C_3	2.3857	1
C_4	7.7128	1	C_4	-0.1595	4

In this section, we analyze the results obtained from the proposed method. Table 1 presents the ranking of the criteria used for supplier selection performance evaluation. The results show that C4, with the highest Q+R score of 7.7128, secured the first rank, while C1, with a Q+R value of 5.3678, ranked second. Similarly, based on the (Q-R) values, C3 secured the first rank with a value of 2.3857. These results clearly indicate that delivery (C4) holds significant importance for customers, as timely delivery is crucial to meeting customer expectations and enhancing satisfaction.

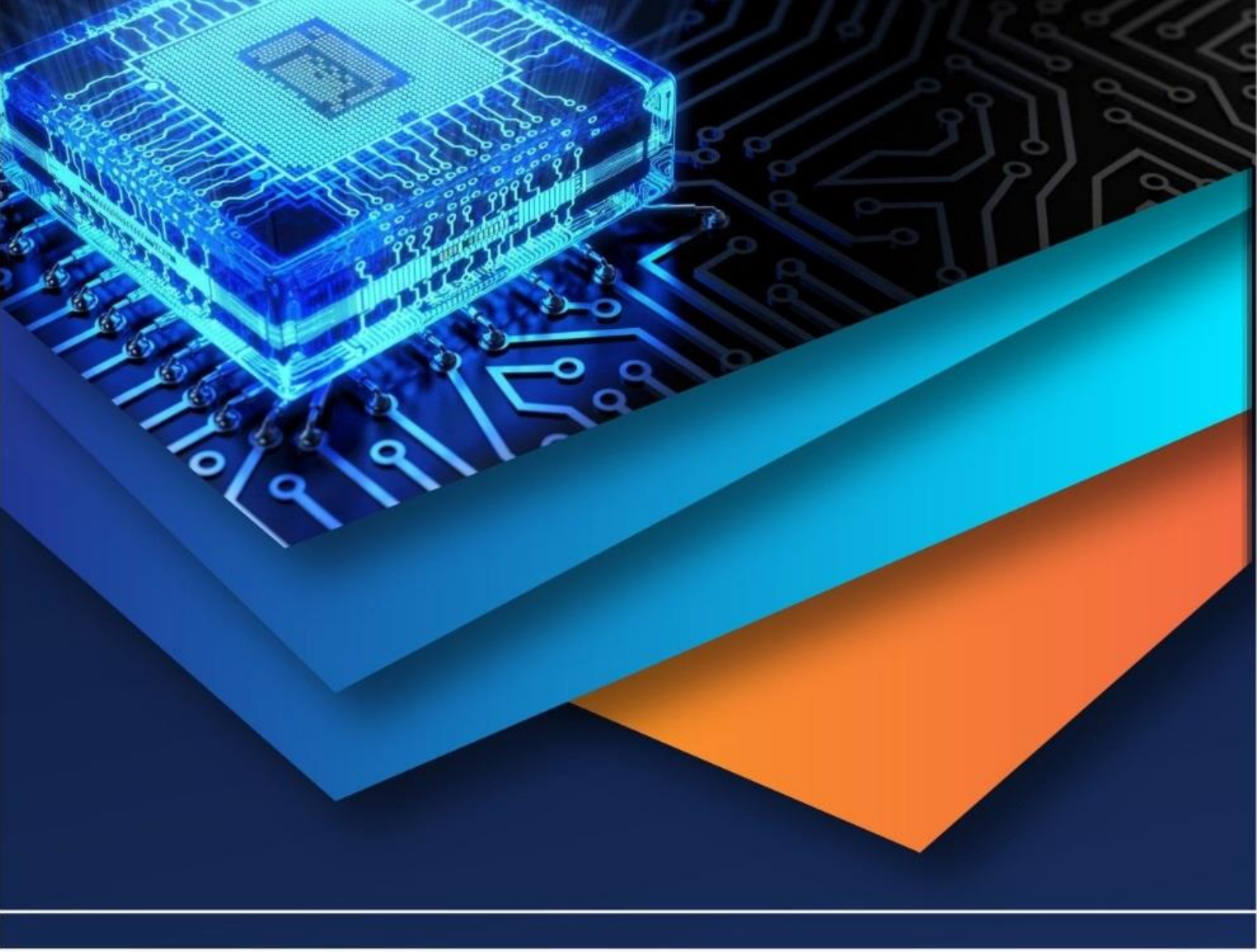
VII. CONCLUSION AND FUTURE WORK

Based on the analysis using the integrated DEMATEL-ANP approach, it is evident that delivery (C4) is the most critical criterion in the supplier selection process within the textile industry, as reflected by its highest Q+R score. This indicates that delivery not only has a strong influence on but also is highly influenced by other criteria, making it central to supplier performance evaluation. Additionally, the (Q-R) score reveals that quality (C3) holds significant net influence, highlighting its importance in driving supplier effectiveness. These findings emphasize the need for textile companies to prioritize suppliers who ensure timely deliveries and maintain consistent quality to enhance supply chain performance and customer satisfaction.

Future work could involve expanding this study by applying the model across different sectors of the textile industry or in different geographical regions to validate its generalizability. Moreover, integrating this approach with real-time data analytics or machine learning techniques could improve dynamic supplier evaluation and adapt to rapidly changing market conditions. Lastly, incorporating sustainability criteria such as environmental impact and ethical practices could further enhance the decision-making process in line with global sustainable development goals.

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