

Evaluating the Importance and Factors Affecting the Export Performance of Machine-Made Carpet Companies Based on Knowledge Domain Analysis and Fuzzy Network Analysis Model

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ABSTRACT

Although many of these insights address broader aspects of supply chain management and export competition among companies, such research lacks empirical evidence regarding the value acquisition of capabilities in companies under study concerning bargaining power and negotiation processes of companies active in the global value chain. Moreover, there is limited assessment of the impact of these factors on the export performance of manufacturing companies, particularly in the machine-made carpet industry. The present study aimed to evaluate the importance and factors influencing the export performance of machine-made carpet companies using knowledge domain analysis and the fuzzy network analysis model. The research methodology was theoretical-applied in terms of purpose, based on a survey research design and descriptive-inductive reasoning. Initially, key metrics affecting export performance were identified through knowledge domain analysis and qualitative content analysis. Subsequently, using a Delphi survey approach, 17 experts and specialists in the export field were selected through non-probability sampling. The fuzzy network multi-criteria analysis model was then employed to evaluate and refine the most effective metrics for measuring variables and to develop the proposed final model.

Keywords: Export performance, machine-made carpet, carpet exports

1. Introduction

Although many of these insights address broader aspects of supply chain management and export competition among companies, such research lacks

empirical evidence regarding the value acquisition capabilities of the companies under study in terms of bargaining power and negotiation processes of companies active in the global value chain. Furthermore, there is limited evaluation of the impact of these factors on the

export performance of manufacturing companies, particularly in the machine-made carpet industry (Arora & Siddiqui, 2022; Kayabasi & Mtetwa, 2016; Martos-Pedrero et al., 2023; Nakabuye, 2023; Pacheco & Matos, 2021).

Export performance plays a critical role in shaping the economic stability and growth of nations, influencing key indicators such as GDP, employment rates, and balance of payments (Dung & Giang, 2021; Pacheco & Matos, 2021). The volume and value of a country's exports are strongly tied to the bargaining power and negotiation processes of its exporters, as well as their ability to create and capture value within the Global Value Chain (GVC) (Niakan Lahiji, Haghighinasab, & Khadivar, 2019). Logistics performance has been identified as a significant driver of controlling transaction costs in exports, closely associated with bilateral trade. However, inefficiencies in logistics represent a major barrier to enhancing productivity and competitive advantage, particularly for exporters in developing economies (Pham et al., 2017). The export supply chain—integrating information sharing, cross-border collaboration, and relationship-building—further underscores the necessity for streamlined logistics systems. Ethical trade practices and corporate social responsibility (CSR) are also integral to ensuring a positive public image and fostering stakeholder trust, which are essential for competitive success in global markets (Radfar, 2023). Similarly, green supply chain management (GSCM) strategies promote sustainability by extending environmental initiatives throughout the supply chain, meeting international environmental standards critical for export compliance (Chakraborty et al., 2023; Hailiang et al., 2023; Mohsin et al., 2023).

Empirical studies highlight the significant impact of export activities on firm growth and survival. Factors such as bargaining power in negotiations, firm age, networking with foreign institutions, R&D intensity, foreign direct investment (FDI), and supply chain participation are consistently cited as key determinants of profitability and export performance (Cadogan et al., 2012; Dung & Giang, 2021; Pacheco & Matos, 2021). The flexibility and efficiency of supply chain management further enhance export performance, with agility, responsiveness, and innovation cited as critical enablers (Cadogan et al., 2012). Metrics for export performance are typically categorized into financial performance—such as export intensity, profitability, and market share growth—and strategic or market performance, including business intelligence and bargaining power during negotiations. Past studies

frequently measure export performance through variables like the number of foreign markets served and the diversity of products sold (Arora & Siddiqui, 2022; Lundberg, 2019; Niakan Lahiji, Haghighinasab, & Khadivar, 2019; Pacheco & Matos, 2021). Across various industries, from automotive to textiles, frameworks such as the SCOR model, dynamic systems, and neural network-based analyses have been employed to evaluate export performance, with emerging technologies like blockchain increasingly integrated to enhance supply chain operations (Niakan Lahiji, Haghighinasab, & Khadivar, 2019).

The global value chain (GVC) concept offers a lens to understand the interconnected activities required to produce goods or services across multiple countries. GVC research focuses on corporate governance within these chains and the conditions that drive producers toward high-value-added activities like marketing and auxiliary services (Malesky & Milner, 2021; Rigo, 2021). Two dominant perspectives frame GVC studies: the political-economic view sees lead firms as exploitative, while the developmental-economic view highlights their role in fostering cost efficiency and value creation. Recent scholarship seeks to reconcile these perspectives, portraying global buyers as both facilitators and barriers to suppliers' efforts to upgrade their roles within GVCs (Behuria, 2020; Flentø & Ponte, 2017; Gereffi, 2013; Nikolakis et al., 2018). In the textile sector, including machine-made carpets, significant export growth has been recorded since 2000, with firms leveraging high-quality production and innovative designs to capture market share, particularly in developing regions such as Iran. However, fragmented industry structures and rising R&D costs pose challenges, as firms must continually innovate and improve bargaining power to maintain competitiveness (Niakan Lahiji, Haghighinasab, & Khadivar, 2019).

The importance and complexities of companies' export performance, combined with supply chain performance, create significant research concerns, leading to the present study. This research aims to confirm variations in export performance among companies over time. It also analyzes and identifies certain critical parameters of supply chain performance that affect companies' export performance through an analytical model and assesses their impact on the export capabilities of companies. The developed model can assist companies in focusing on specific areas of supply chain performance to enhance their export capabilities (Martos-Pedrero et al., 2023; Nakabuye, 2023). For the sake of clarity in explaining the proposed model, the first

two strategies are referred to as "functional upgrading initiatives," and the latter two as "negotiation or bargaining process initiatives."

2. Methods and Materials

2.1. Study Design and Participants

This study followed a mixed-methods approach, combining qualitative and quantitative methods to identify, rank, and analyze the factors affecting export performance in machine-made carpet companies in Kashan. The design involved a systematic review of the relevant literature, followed by expert input and advanced analytical techniques.

Participants were selected using purposive sampling, focusing on individuals with substantial expertise in the fields of export performance, supply chain management, and global value chains. A total of 17 participants, including university professors, senior managers, and industry specialists, were recruited. The criteria for selection required participants to hold at least a master's degree and possess extensive experience in carpet exports.

2.2. Data Collection

Data collection consisted of two main phases:

1. **Literature Review and Metric Identification:**
The first phase involved identifying initial metrics and factors influencing export performance through a comprehensive literature review. This was achieved using knowledge domain analysis and qualitative content analysis. Relevant dimensions such as bargaining power, negotiation skills, market intelligence, product development, sales promotion, and distribution process improvement were identified and refined.
2. **Expert Validation through the Delphi Method:**
In the second phase, a Delphi survey was conducted to validate and refine the identified metrics. Experts participated in multiple rounds of structured surveys designed to achieve consensus on the most critical factors. Their input ensured that the metrics were relevant and practical, addressing the unique challenges faced by companies in the carpet export industry. Iterative rounds allowed for the refinement of factors, ensuring consistency and alignment with expert opinions.

2.3. Data Analysis

The Analytic Network Process (ANP) was employed to analyze and prioritize the factors influencing export performance. This method was chosen for its ability to address interdependencies and feedback loops among various elements, overcoming the limitations of the more linear Analytic Hierarchy Process (AHP). The ANP process was conducted in four steps:

1. **Model Construction and Network Structuring:**
The identified factors were organized into a network structure that reflected their interdependencies. This structure comprised clusters representing key dimensions (e.g., bargaining power, market intelligence) and elements within those clusters (e.g., specific metrics like decision-making power or market awareness). Connections within and across clusters captured both internal and external dependencies. This structure was finalized through expert discussions.
2. **Pairwise Comparisons and Priority Assignments:**
Experts were asked to compare elements within and across clusters to determine their relative importance. Comparisons were made using a nine-point scale to ensure precision in capturing the strength of relationships. This process included assessing not only the elements' direct impact on export performance but also their influence within the network. The judgments were checked for consistency, and revisions were made where necessary to ensure reliability.
3. **Supermatrix Formation and Weight Calculations:**
A supermatrix was developed to represent the interrelationships among the clusters and elements. This matrix was normalized to account for the relative weights of the elements and ensure comparability across different dimensions. Iterative calculations were performed to determine the final priority weights of all factors. These weights represented the global importance of each element in contributing to export performance.
4. **Selection of Key Factors:**
The final output of the ANP analysis provided a ranked list of factors based on their overall influence. This prioritization helped identify the most critical dimensions and sub-dimensions that companies should focus on to

improve their export performance. Factors such as enhancing bargaining power, fostering market intelligence, and improving distribution processes emerged as highly influential.

3. Findings and Results

In this research, based on the defined model, the identification of factors influencing the export performance of machine-made carpets and their measurement metrics was initially conducted through knowledge domain analysis and content analysis. Subsequently, using expert surveys through the Delphi method and fuzzy network analysis, the factors were refined. This section of the paper provides an analysis of the summarized research findings.

Based on knowledge domain analysis and content analysis modeling, the importance of export performance and the most significant influencing factors were identified and categorized.

The study employed the fuzzy Delphi method to evaluate the relevance of factors identified from the literature review with the contexts and conditions of export performance, following these execution steps:

Step 1: Selection of Experts

The main criteria for selecting experts in this study were possessing specialized knowledge and relevant experience in export performance and its influencing factors, holding at least a master's degree, and active participation in capital markets. Seventeen experts were chosen, including six academic faculty members, nine senior managers and experts from the banking sector, and two specialists in machine-made carpet exports.

Step 2: Building the Model and Creating a Network Structure

To determine the relationships among the dimensions and components influencing export performance, surveys were conducted among all 17 experts.

Step 3: Determining Weights of Key Dimensions

Pairwise comparison matrices were used to calculate the weights of five key dimensions: negotiation skills, market intelligence, product development, sales promotion, and distribution process improvement. Saaty's nine-point scale (1994) was applied for pairwise comparisons conducted by the experts. The consistency index (CI) and consistency ratio (CR) were used to ensure consistency in the comparisons. If CI and CR values exceeded 0.1, the experts were asked to revise their judgments. In this study, Decision Super software was used for calculations, and all pairwise comparisons achieved CI and CR values below 0.1, meeting the consistency threshold defined by Saaty.

Step 4: Pairwise Comparisons of Components and Supermatrix Construction

The weights of the components within each of the five dimensions were calculated similarly to the AHP method. Additional pairwise comparisons were conducted to show the interdependencies between components within each dimension. The priority weights were incorporated into an unweighted supermatrix.

Using Super Decision software, the study normalized the supermatrix to ensure the column sums equaled one, thereby achieving stochastic probabilities. The normalized supermatrix revealed the final importance weights of each component within the five dimensions, demonstrating their contribution to export performance and bargaining power as outlined in the proposed research model.

Step 5: Determination of Weights for Independent Dimension Components

Based on the multi-criteria fuzzy network analysis model described earlier, the final importance weights and prioritization of dimensions and components affecting export performance behaviors are presented in [Table 1](#).

Table 1

Final Importance Weights and Prioritization of Dimensions and Components Influencing Export Performance

Row	Variable Description	Symbol	Measurement Metric	Weight	Component Rank	Variable Weight	Variable Rank
1	Export Performance	EP1	Percentage growth in export volume compared to previous periods	0.0317	2	0.1706	2
2		EP2	Percentage growth in export sales revenue compared to previous periods	0.0278	3		
3		EP3	Percentage growth in profit from exports compared to previous periods	0.0238	4		
4		EP4	Percentage growth in the number of export markets	0.0317	2		

5		EP5	Percentage growth in new export markets compared to previous periods	0.0198	5		
6		EP6	Percentage growth in sales to previous foreign customers	0.0357	1		
7	Bargaining Power	BP1	Decision-making power over contract pricing	0.0198	3	0.1071	5
8		BP2	Decision-making power over product features	0.0159	4		
9		BP3	Decision-making power over payment terms	0.0238	2		
10		BP4	Decision-making power over delivery conditions	0.0278	1		
11		BP5	Decision-making power over transaction volume	0.0198	3		
12	Negotiation Skills	NS1	Effective negotiation strategy skills	0.0238	3	0.1468	3
13		NS2	Effective verbal communication skills	0.0198	4		
14		NS3	Ability to persuade business partners	0.0317	1		
15		NS4	Problem-solving skills	0.0238	3		
16		NS5	Ability to maintain good relations with partners	0.0278	2		
17	Market Intelligence	NS6	Ability to act decisively during negotiations	0.0198	4	0.1270	4
18		MI1	Awareness of changes in export markets	0.0238	3		
19		MI2	Awareness of customer preferences in export markets	0.0278	2		
20		MI3	Awareness of pricing and cost structures of similar products	0.0238	3		
21		MI4	Awareness of changes in export marketing channels	0.0198	4		
22	Product Development	MI5	Awareness of demand and taste changes in export markets	0.0317	1	0.1071	5
23		MC1	Adapting products to customer preferences in export markets	0.0159	3		
24		MC2	Developing and introducing new products in export markets	0.0317	1		
25		MC3	Introducing new services in export markets	0.0278	2		
26		MC4	Establishing product development systems related to exports	0.0317	1		
27	Sales Promotion	SP1	Advertising expenses in export markets	0.0159	4	0.0992	6
28		SP2	Participation in international trade fairs	0.0238	3		
29		SP3	Export-specific marketing-communication planning	0.0278	2		
30		SP4	Executing sales promotion programs in export markets	0.0317	1		
31	Distribution Process Improvement	DP1	Direct product distribution in export markets	0.0278	3	0.2143	1
32		DP2	Streamlining export processes	0.0238	4		
33		DP3	Establishing close relationships with wholesalers in export markets	0.0278	3		
34		DP4	Establishing close relationships with retailers in export markets	0.0198	5		
35		DP5	Providing technical services in export markets	0.0278	3		
36		DP6	Guaranteeing and warranting products in export markets	0.0317	2		
37		DP7	Offering after-sales support in export markets	0.0357	1		
38		DP8	Guaranteeing returns for unwanted or defective products	0.0198	5		
39	Control Variables	Size	Natural log of the company's number of employees	0.0119	2	0.0278	7
40		Expr	Natural log of the company's years in export markets	0.0159	1		

Table 1 includes detailed rankings and weights for other dimensions such as negotiation skills, market intelligence, product development, sales promotion, and distribution process improvement.

Through a systematic and logical process using expert judgment in surveys and a quantitative multi-variable fuzzy network analysis model, the importance levels, rankings, and refinement of export performance and its influencing factors were assessed.

Table 2

Export Performance and Influencing Factors (Delphi Survey and Fuzzy Network Analysis)

Row	Variable Description	Symbol	Measurement Metric
1	Export Performance	EP1	Percentage growth in export volume compared to previous periods
2		EP2	Percentage growth in export sales revenue compared to previous periods
3		EP3	Percentage growth in profit from exports compared to previous periods
4		EP4	Percentage growth in the number of export markets
5		EP5	Percentage growth in new export markets compared to previous periods
6	Bargaining Power	EP6	Percentage growth in sales to previous foreign customers
7		BP1	Decision-making power over contract pricing
8		BP2	Decision-making power over product features
9		BP3	Decision-making power over payment terms
10		BP4	Decision-making power over delivery conditions
11	Negotiation Skills	BP5	Decision-making power over transaction volume
12		NS1	Effective negotiation strategy skills
13		NS2	Effective verbal communication skills
14		NS3	Ability to persuade business partners
15		NS4	Problem-solving skills
16	Market Intelligence	NS5	Ability to maintain good relations with partners
17		NS6	Ability to act decisively during negotiations
18		MI1	Awareness of changes in export markets
19		MI2	Awareness of customer preferences in export markets
20		MI3	Awareness of pricing and cost structures of similar products
21	Product Development	MI4	Awareness of changes in export marketing channels
22		MI5	Awareness of demand and taste changes in export markets
23		MC1	Adapting products to customer preferences in export markets
24		MC2	Developing and introducing new products in export markets
25		MC3	Introducing new services in export markets
26	Sales Promotion	MC4	Establishing product development systems related to exports
27		SP1	Advertising expenses in export markets
28		SP2	Participation in international trade fairs
29		SP3	Export-specific marketing-communication planning
30		SP4	Executing sales promotion programs in export markets
31	Distribution Process Improvement	DP1	Direct product distribution in export markets
32		DP2	Streamlining export processes
33		DP3	Establishing close relationships with wholesalers in export markets
34		DP4	Establishing close relationships with retailers in export markets
35		DP5	Providing technical services in export markets
36	Control Variables	DP6	Guaranteeing and warranting products in export markets
37		DP7	Offering after-sales support in export markets
38		DP8	Guaranteeing returns for unwanted or defective products
39		Size	Natural log of the company's number of employees
40		Expr	Natural log of the company's years in export markets

The detailed breakdown reflects the integration of expert opinions and quantitative analysis to finalize the metrics for evaluating export performance and related influencing factors. The weights and ranks provide practical guidance for focusing on key components in export strategies.

4. Discussion and Conclusion

Initially, through knowledge domain analysis and qualitative content analysis, measurement metrics for the export performance of machine-made carpet companies and

the factors influencing them were identified. Subsequently, using the Delphi method for consensus-based surveys, 17 experts and specialists in carpet exports were selected non-randomly. Using a multi-criteria fuzzy network analysis model, the most effective measurement metrics were evaluated, refined, and incorporated into the proposed final model.

Although many of these insights address broader aspects of supply chain management and export competition among companies, such studies lack empirical evidence related to the value acquisition capabilities of the examined

companies in terms of bargaining power and negotiation processes within the Global Value Chain (GVC). Moreover, there is limited evaluation of the impact of these factors on the export performance of manufacturing companies, particularly in the machine-made carpet industry (Chakraborty et al., 2023; Hailiang et al., 2023; Martos-Pedrero et al., 2023; Mohsin et al., 2023; Nakabuye, 2023; Radfar, 2023).

The analysis of a predictive model linking companies' supply chain performance to export capabilities is expected to assist machine-made carpet companies in Kashan in identifying the impact of supply chain performance on bargaining power, negotiation processes, and export performance. Using an interpretive structural modeling approach, this framework can enable the companies to better recognize the influence of supply chain performance on their bargaining power and export negotiations. Additionally, it can assist senior managers, policymakers, and oversight bodies within the Kashan carpet cluster to make informed decisions regarding various supply chain performance parameters to improve their export capabilities.

The importance and complexities of companies' export performance, combined with supply chain performance, have created significant research concerns, prompting this study. This research aimed to validate changes in export performance across companies over time. It also analyzed and identified certain critical supply chain performance parameters affecting export performance through an analytical model. Furthermore, it evaluated how these supply chain performance parameters impact companies' export capabilities.

The developed model can help companies focus on specific areas of supply chain performance to enhance their export capabilities (Arora & Siddiqui, 2022; Kayabasi & Mtetwa, 2016; Pham et al., 2017).

An analysis of the literature, based on theoretical foundations and empirical evidence from previous studies, shows that to achieve economic advantages, companies must not only create value for their customers but also secure a fair share of the potential or realized final value within the supply chain relative to suppliers, distributors, and end-users (Behuria, 2020; Dung & Giang, 2021; Malesky & Milner, 2021; Pacheco & Matos, 2021).

Authors' Contributions

S.R.L. initiated the research, defined the research problem, and led the knowledge domain analysis. H.G.G. contributed to the theoretical framework, conducted qualitative content analysis, and helped design the Delphi survey. H.P. assisted in the implementation of the fuzzy network analysis model and the evaluation of export performance metrics. M.A. participated in data collection through the Delphi survey, while H.J. contributed to the analysis of results and refinement of the proposed model. All authors collaborated in drafting and revising the manuscript for publication.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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