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Evaluation and Prioritization of Value Chain Improvement Strategies in Manufacturing and Service Industries with a Combined TOPSIS and Fuzzy TOPSIS Approach

Vahid Taher Khani[1], Meysam Sharifi [2] ,Mohammad Shafieian[3],Faezeh Lorestani[4] , Mohammad Javad Arabnejad[5], Masoomeh Zarei [6]

1. Bachelor of Professional Engineering in Industrial Safety (HSE) and Master of Industrial Engineering in Engineering Management from Isfahan University of Technology
2. Bachelor of industrial engineering and Master of industrial engineering in Engineering Management from Isfahan University of Technology
3. Bachelor of Mechanical Engineering and Master of Industrial Engineering in Engineering Management from Isfahan University of Technology
4. Bachelor of applied Chemistry and Master of medical biochemistry and industrial engineering in Engineering Management from Isfahan University of Technology
5. Bachelor of industrial engineering and Master of industrial engineering in Engineering Management from Isfahan University of Technology
6. Bachelor of Economics and Master of Industrial Engineering in Engineering Management from Isfahan University of Technology

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ABSTRACT

The aim of this research is to provide an integrated decision-making framework for evaluating and prioritizing value chain improvement strategies in manufacturing and service industries using a combined TOPSIS and fuzzy TOPSIS approach. In the first step, the main and supporting activities of the value chain in the manufacturing sector are evaluated based on criteria such as operational efficiency, cost, quality, and flexibility and are ranked using the TOPSIS method. Next, for the service sector, which is associated with more uncertainty and linguistic judgments, value chain improvement strategies are analyzed and prioritized using fuzzy TOPSIS using criteria such as customer satisfaction, service speed, risk, and value creation. In the final stage, the results of the two parts are combined and a comprehensive model is presented for selecting the best value chain improvement strategies. The research findings show that combining classical and fuzzy methods can provide a more accurate picture of the state of the value chain in different industries and help managers make more effective strategic decisions. This framework has applicability in manufacturing industries, financial services, health, information technology and other economic sectors and can be a basis for improving the competitiveness and performance of organizations.

Introduction

1 -Problem Definition:

In today's competitive environment, manufacturing and service organizations need to continuously improve their value chain to maintain and enhance their position. The value chain, as a comprehensive framework, analyzes the organization's core and supporting activities in the path of creating value for customers. However, the complexity of processes, the diversity of activities, and the substantive differences between manufacturing and service industries have made evaluating and selecting value chain improvement strategies a major challenge for managers. The lack of an integrated decision-making model that can cover these differences and complexities has created an important gap in the literature and management practice. On the other hand, decision-making in the field of value chain improvement is usually accompanied by multiple and sometimes contradictory criteria; criteria such as cost, quality, efficiency, customer satisfaction, risk, and value creation. In manufacturing industries, data is often quantitative and measurable, and classic methods such as TOPSIS can be used to rank activities and identify weaknesses. However, in service industries, human judgments, uncertainty, and linguistic data play a more prominent role, and the use of fuzzy methods such as fuzzy TOPSIS becomes necessary. This essential difference between the two sectors highlights the need for an integrated approach.

Therefore, the main research question is how to provide an integrated and efficient decision-making framework that, while covering the structural differences between manufacturing and service industries, allows for accurate assessment of value chain activities and prioritization of improvement strategies. The integrated approach of TOPSIS and fuzzy TOPSIS can provide a more comprehensive picture of the status of the value chain by combining quantitative and qualitative data and help managers make more optimal strategic decisions. This research seeks to design, implement, and validate this framework so that it can be used as a practical tool to improve the performance and competitiveness of organizations.

2 -Problem Classification:

According to the content presented in the abstracts of the two articles, the following classifications can be considered for the problems raised in them:

2-1 -First article:

Main topic: Evaluating the efficiency of value chain activities in manufacturing industries using the TOPSIS method

2-1-1 -Nature of the problem

The problem is a multi-criteria decision-making (MCDM) type problem in which value chain activities are considered as options and performance criteria such as cost, quality, efficiency, time and flexibility are considered as evaluation indicators. The goal is to measure and rank the efficiency of various value chain activities in a manufacturing industry.

2-1-2 -Application Domain

This problem falls within the scope of operations management and supply chain management. Manufacturing industries such as automobile, steel, food, pharmaceutical and electronics can use this model to identify weaknesses and improve their value-creating activities.

2-1-3-Type of Data

The data used are mostly quantitative and measurable; such as operating costs, production cycle time, scrap rates, labor productivity, and quality indicators. This feature makes the TOPSIS method a suitable technique for analyzing deterministic data.

2-1-4-Type of Analysis

The analysis is a type of efficiency evaluation and ranking. In this analysis, the distance of each activity from the positive and negative ideal solution is calculated and the activities are ranked based on their proximity to the desired state. The goal is to identify inefficient activities and determine improvement priorities.

2-1-5-Expected Output

The research output includes:

- Ranking of value chain activities
- Identifying critical and inefficient activities
- Providing improvement suggestions based on TOPSIS results

•Creating a decision-making model for production managers

2-1-6-Stakeholders

Production managers, supply chain managers, productivity analysts, strategic planners, and researchers in the field of industrial management will benefit from the results of this problem.

2-2Second Paper:

Main Topic: Prioritizing Value Chain Improvement Strategies in Service Companies Using Fuzzy TOPSIS

-2-2-1Nature of the Problem

The problem is a multi-criteria decision-making problem under uncertainty. Value chain improvement strategies are considered as options and criteria such as customer satisfaction, service quality, cost, service delivery speed, risk, and value creation are considered as evaluation indicators. Due to the subjective and linguistic nature of judgments in the service sector, the problem falls within the domain of fuzzy analysis.

-2-2-2Application Domain

This problem arises in the fields of service management, operations management, and value chain management. Service companies such as banks, insurance, hospitals, information technology companies, tourism, and education can use this model to select the best improvement strategies.

-2-2-3Type of Data

The data is mainly qualitative, linguistic and based on expert judgment. Terms such as “high”, “medium”, “low” or “very important” are modeled as triangular or trapezoidal fuzzy numbers. This feature necessitates the use of fuzzy TOPSIS.

-2-2-4Type of Analysis

The analysis is a type of prioritization of strategies. In this analysis, the distance of each strategy from the ideal positive and negative fuzzy solution is calculated and the strategies are ranked based on their proximity to the desired state. The goal is to select the best strategies for improving the value chain in an environment of uncertainty.

-2-2-5Expected Output

The output includes:

•Ranking of value chain improvement strategies

•Identifying the most important impactful metrics

•Providing a decision-making model for service managers

•Practical suggestions for improving service quality and efficiency

-2-2-6Stakeholders

Senior service managers, quality managers, business analysts, customer experience specialists, strategic planners, and researchers in the field of service management will benefit from the results of this issue.

1 -Mathematical Modeling:

3-1 First Article

3-1-1-Main Components of the Model

•Options (Activities): A set of value chain activities in the manufacturing industry (e.g., inbound logistics, operations, outbound logistics, marketing and sales, after-sales service, and support activities such as human resources, technology, infrastructure)

•Evaluation Criteria: A set of indicators such as cost, quality, time, productivity, flexibility, innovation, customer satisfaction, and operational risk that are used to measure the efficiency of each activity.

•Criteria Weights: For each criterion, an importance weight is considered that indicates to what extent that criterion plays a role in evaluating the efficiency of the activities (weights can be determined through experts, AHP, or other methods).

•Decision matrix: A table in which rows represent value chain activities and columns represent criteria, and in each cell, the performance value of an activity relative to a criterion is recorded.

3-1-2-Conceptual steps of the TOPSIS method in the form of a model

1 .Data normalization: The performance values of activities relative to each criterion are transformed in such a way that they become comparable (for example, all are placed on the same scale).

2 .Applying criterion weights: The importance of each criterion is applied to the normalized values to

increase the influence of more important criteria in the evaluation.
3 .Definition of the positive and negative ideal solution: For each criterion, a desirable value (the best possible situation between activities) and an undesirable value (the worst possible situation) are determined.
for benefit criteria (e.g. quality, productivity): a higher value is more desirable.
for cost criteria (e.g. cost, time, risk): a lower value is more desirable.
4 .Calculate the distance of each activity from the positive and negative ideal state: For each activity, a total distance from the desired state and a total distance from the undesirable state are calculated (without writing a formula, the concept is that the closer the activity is to the desired values and the further away from the undesirable values, the better).
5 .Calculate the proximity index to the ideal solution: For each activity, a numerical index is defined that shows its proximity to the desired state; the larger this index, the more efficient the activity is.
6 .Rank the activities: The value chain activities are sorted based on the proximity index value, and thus, efficient and inefficient activities are identified.
3-1-4-Model output
•Rank the value chain activities in the manufacturing industry based on relative efficiency.
•Identify critical activities that require immediate improvement.
•Provide a quantitative basis for management decision-making in resource allocation, process redesign, and value chain improvement.

3-2Second article:
-3-2-1Main components of the model
•Options (strategies): A set of strategies for improving the value chain in a service company, such as: digitizing processes, improving service quality, reducing service delivery time, developing customer communication channels, training and empowering employees, outsourcing some activities, etc.
•Evaluation criteria: A set of indicators such as customer satisfaction, service quality, implementation cost, speed of service delivery, risk, flexibility, value creation, and alignment with the organization's macro strategy.
•Criteria weights (fuzzy): The importance of each criterion is determined based on expert judgment in the form of linguistic expressions such as "very high", "high", "average", etc. These linguistic expressions are displayed in the model as fuzzy numbers (for example, triangular or trapezoidal).
•Fuzzy decision matrix: A table in which rows represent strategies and columns represent criteria, and in each cell, the experts' fuzzy assessment of the performance of a strategy relative to a criterion (e.g., "good", "very good", "average") is recorded.

-3-2-2Logic and conceptual steps of fuzzy TOPSIS in the form of a model
1. Converting linguistic judgments into fuzzy values: Experts' linguistic assessments of the importance of criteria and the performance of strategies are converted into corresponding fuzzy values to preserve uncertainty and ambiguity in the judgments.
2. Forming a weighted fuzzy decision matrix: The fuzzy values of the performance of strategies are combined with the fuzzy weights of the criteria to increase the influence of more important criteria in the final evaluation.
3. Determining the positive and negative fuzzy ideal solution: For each criterion, a positive fuzzy ideal state (the best possible level of performance among the strategies) and a negative fuzzy ideal state (the worst level of performance) are defined.
for profit criteria (e.g. customer satisfaction, quality, value creation): higher levels are more desirable.
for cost and risk criteria: lower levels are more desirable.
4. Calculating the fuzzy distance of each strategy from the positive and negative ideal state: For each strategy, a fuzzy distance from the desirable state and a fuzzy distance from the undesirable state are calculated. The concept of this step is that a strategy is more suitable if it is closer to the desirable state and further from the undesirable state.
5. Calculating the fuzzy proximity index for each strategy: For each strategy, a proximity index (as a final value) is obtained that shows how close that strategy is to the fuzzy ideal solution. The larger this index,

the more appropriate the strategy.
6.Ranking of strategies: Value chain improvement strategies are sorted based on the value of the proximity index, and thus, the best strategies for implementation in a service company are identified.
-3-2-3Model output
•Ranking of value chain improvement strategies in a service company.
•Identifying superior strategies by simultaneously considering quantitative and qualitative criteria and judgment uncertainty.
•Determining key criteria affecting the selection of improvement strategies.
•Creating a fuzzy decision-making framework for service managers to select and implement value chain improvement strategies.

1.Problem-solving method:
4-1First article:
1. Defining activities and criteria Activities: Identifying value chain activities (inbound procurement, operations, outbound procurement, marketing and sales, after-sales service, and support activities). Criteria: Determining performance evaluation criteria such as cost, quality, time, productivity, flexibility, innovation, and customer satisfaction. Type of criteria: Specifying whether each criterion is of the profit (more is better) or cost (less is better) type.
2. Data collection Collecting quantitative data related to the performance of each activity relative to each criterion (e.g., cost of each activity, time of completion, quality index, waste rate, productivity, etc.). If necessary, using expert opinion to supplement or adjust the data.
3. Determining criterion weights Determining the relative importance of each criterion using methods such as expert judgment, AHP, entropy, or any other appropriate method. The weights should be such that their sum is equal to one (or on an acceptable scale).
4. Forming a decision matrix Constructing a table in which the rows represent the value chain activities and the columns represent the criteria, and in each cell, the performance value of an activity relative to a criterion is recorded.
5.Normalizing the decision matrix Converting the raw values of the criteria into normalized values so that the criteria can be compared with different scales (for example, cost in rials, time in hours, quality in percentage)
6. Forming a weighted normalized matrix Applying the weights of the criteria to the normalized values, so that the more important criteria have a greater impact on the final evaluation.
7. Determining the positive and negative ideal solution for each criterion, determining:
The best value (positive ideal solution) among activities
o The worst value (negative ideal solution) among activities according to the type of criterion (profit or cost)
8. Calculating the distance of each activity from the positive and negative ideal solution For each activity, a total distance from the desired state and a total distance from the undesirable state are calculated. The smaller the distance from the desired state and the greater the distance from the undesirable state, the more efficient the activity is.
9. Calculating the proximity index to the ideal solution For each activity, a proximity index is defined that shows its proximity to the desired state. The value of this index is between zero and one, and the closer it is to one, the more efficient the activity is.
10.Ranking the activities of the value chain Activities are sorted based on the proximity index value and the rank of each activity is determined. Activities with a higher rank are more efficient, and activities with a lower rank need improvement.
11. Analyze results and provide suggestions
•Identify critical and inefficient activities in the value chain
•Analyze the causes of the weakness of these activities (high cost, low quality, long time, etc.)
•Provide improvement strategies to improve the efficiency of the value chain in the manufacturing industry under study

4-2 Second article:

1 .Definition of strategies and criteria Strategies: Identifying strategies for improving the value chain in a service company (e.g., digitizing processes, improving service quality, reducing service delivery time, developing customer communication channels, training employees, etc.). Criteria: Determining evaluation criteria such as customer satisfaction, service quality, implementation cost, speed of service delivery, risk, flexibility, value creation, and alignment with the macro strategy. Type of criteria: Specifying profit criteria (more is better) and cost criteria (less is better)
2 .Designing fuzzy linguistic scales Defining linguistic expressions for evaluations, such as:
for the importance of criteria: "very high", "high", "average", "low"
for the performance of strategies: "very good", "good", "average", "poor" Then determining a fuzzy equivalent (e.g., triangular or trapezoidal) for each linguistic expression.
3 .Collecting expert judgments Selecting experts (managers, service experts, quality specialists, etc.) and receiving their evaluations:
The importance of each criterion in linguistic form
The performance of each strategy against each criterion in linguistic form These judgments will be the basis for forming fuzzy data.
4 .Forming a fuzzy decision matrix and fuzzy weights of criteria
Converting the linguistic assessments of experts into corresponding fuzzy numbers
Aggregating judgments (e.g. fuzzy averaging) to obtain a final fuzzy decision matrix
Calculating the fuzzy weights of criteria based on the linguistic judgments of the importance of criteria
5 .Forming a weighted fuzzy decision matrix Applying the fuzzy weights of criteria to the fuzzy values of the performance of strategies, so that more important criteria have a greater impact on the final evaluation.
6 .Determine the ideal positive and negative fuzzy solution for each criterion, determining:
Ideal positive fuzzy solution: The best fuzzy performance level among the strategies
Ideal negative fuzzy solution: The worst fuzzy performance level among the strategies according to the type of criterion (profit or cost)
7 .Calculate the fuzzy distance of the strategies from the ideal solutions For each strategy, the fuzzy distance from the positive and negative ideal solution is calculated. The desired strategy is the strategy that is closest to the positive ideal solution and farthest from the negative ideal solution.
8 .Calculate the fuzzy proximity index and defuzzification
For each strategy, a fuzzy proximity index to the ideal solution is calculated.
These fuzzy indices are then converted to definite values (defuzzification) to allow numerical comparison.
9 .Rank the strategies The strategies are sorted based on the value of the definite proximity index; The strategy with a higher index has a higher priority for implementation.
10 .Analyze results and provide recommendations
•Identify superior strategies for improving the value chain
•Analyze the role of key criteria in selecting strategies
•Provide executive recommendations for service managers to implement the selected strategies

1.Literature Review

5-1First article:

-5-1-1Literature Review

Research related to value chain evaluation in manufacturing industries shows that the use of multi-criteria decision-making methods, especially TOPSIS, has gained a significant position as a structured approach for analyzing the efficiency of activities. These studies usually focus on identifying key value chain activities and measuring their performance based on quantitative criteria such as cost, time, quality and productivity. The TOPSIS approach has been used in many studies as the main tool for ranking activities due to its simplicity, high interpretability and the possibility of using real data. However, a significant part of the existing literature has paid less attention to the dynamic complexities of the value chain, interactions between activities and environmental impacts. Also, many studies have relied on definitive data and ignored the uncertainties in managerial judgments or fluctuations in the production environment. Therefore, although TOPSIS is considered an efficient method in the

literature, the need to develop more intelligent and hybrid models is still felt.

-5-1-2Strengths

•Structured analysis: The TOPSIS method allows for a systematic and transparent assessment of value chain activities.

•Ability to use real data: Manufacturing industries usually have quantitative and measurable data that is compatible with TOPSIS.

•Accurate identification of inefficient activities: The ranking output helps managers to identify the weaknesses of the value chain numerically.

•Simplicity and implement ability: TOPSIS is simpler and faster to implement than more complex methods such as DEA or fuzzy models.

•High applicability in various industries: From the automotive and steel industries to the food and pharmaceutical industries, everyone can benefit from this model.

-5.1.3Weaknesses

•Ignoring uncertainty: Deterministic data may not fully reflect the realities of the production environment.

•Not considering interactions between activities: TOPSIS assumes activities to be independent, while in the value chain, activities are highly interdependent.

•Sensitivity to criteria weighting: Results are strongly influenced by the weight of criteria, and determining weights may be subjective.

•Model staticity: Many studies do not consider environmental changes, market fluctuations, or digital transformation in the analysis.

•Lack of implementation solutions: Most studies simply provide rankings and do not analyze in-depth the causes of inefficiency.

-5.1.4Future research

Combining TOPSIS with fuzzy or gray methods: To consider uncertainty and managers' linguistic judgments.

Use of combined TOPSIS–AHP or TOPSIS–BWM models: To determine more accurate weights and reduce subjectivity in weighting.

Employing artificial intelligence and machine learning: To predict the performance of value chain activities and analyze future trends.

Dynamic value chain modeling: Using simulation or dynamic systems to analyze the interactions of activities.

Developing intelligent decision-making dashboards: To provide real-time analysis and help managers make quick decisions.

Focus on sustainability and social responsibility: Future research shows that environmental and social criteria will soon become the main criteria for evaluating the value chain.

5-2Second article:

-5-2-1Literary review

Research literature in the field of value chain in service companies shows that the service sector is more complex than manufacturing industries due to its intangible nature, dependence on human interaction and diversity of customer expectations. Many studies have emphasized the importance of improving value-creating activities such as service quality, service delivery speed, customer experience and innovation. However, evaluating and prioritizing improvement strategies in this area is usually accompanied by uncertainty, ambiguity and subjective judgments. The fuzzy TOPSIS method has been introduced in the literature as a suitable approach to managing this uncertainty, because it allows the conversion of experts' linguistic judgments into fuzzy values and their analysis. However, a significant part of the research has only focused on ranking strategies and has less focused on in-depth analysis of the relationships between criteria, the dynamics of the service environment and the long-term effects of strategies. Therefore, although fuzzy TOPSIS has an established place in the literature, its potential for development and improvement is still considerable.

-5.2.2Strengths

•Suitability of the method to the nature of services: The use of linguistic and subjective data of experts is fully compatible with the fuzzy nature of decision-making in services.

•Ability to manage uncertainty: Fuzzy TOPSIS models the ambiguity in the evaluation of criteria such as quality, customer satisfaction, and risk well.

•Structured and understandable: The ranking process is transparent and managers can easily interpret the results.

•High applicability: This model can be used in banks, insurance, hospitals, IT companies, tourism, and other services.

•Possibility of combination with other methods: Ability to integrate with AHP, BWM, ANP, or machine learning methods to increase accuracy and validity.

-5.2.3Weaknesses

•Dependence on expert opinion: The quality of the results depends strongly on the accuracy and experience of experts.

•Lack of attention to service dynamics: Many models do not consider the rapid changes in the service environment, customer behavior, and technology.

•Assumption of independence of criteria: Fuzzy TOPSIS ignores the internal relationships between criteria (e.g., the relationship between quality and customer satisfaction).

•Lack of implementation solutions: Most studies are limited to rankings and do not provide an action plan.

•Challenge in determining linguistic scales: Choosing appropriate fuzzy scales can be subjective and vary between researchers.

5-2-4-Future of Research

Combining Fuzzy TOPSIS with Machine Learning Methods: To predict customer behavior and analyze future service trends.

Using Dynamic Models: Employing dynamic systems or simulations to analyze the long-term effects of strategies.

Developing Hybrid Models: Integrating Fuzzy TOPSIS with AHP, BWM, ANP, or Gray Methods to increase the accuracy of weighting and analysis.

Focusing on Customer Experience and Digitalization: The future of services is moving towards intelligence, automation, and personalized customer experience.

Adding Sustainability Criteria: Environmental, social, and ethical criteria will soon become the main criteria for evaluating service strategies.

Creating Smart Decision Dashboards: To provide real-time analytics and help managers choose improvement strategies.

Analysis Gap Table:

Components	Article 1	Article 2
Research Scope	Focus on value chain activities in manufacturing industries	Focusing on Value Chain Improvement Strategies in Service Companies
Data Type	Quantitative, deterministic, measurable data	Qualitative, Linguistic, Uncertainty-Based Data
Decision Making Method	Classic TOPSIS	Fuzzy TOPSIS
Strengths of Existing Research	Simplicity of analysis, access to real data, possibility of accurate ranking of activities	Uncertainty Management Ability, Suitability to the Nature of Services, Flexibility in Analyzing Human Judgments
Weaknesses of Existing Research	Ignoring uncertainty, assuming independence of activities, model stationarity	Reliance on Expert Opinion, Lack of Attention to Service Dynamics, Challenge in Determining Fuzzy Scales
Research Gaps	- No use of mixed models	---

Conclusion:

In summary of the two articles, it can be said that the value chain plays a fundamental role in creating value, increasing productivity, and promoting the competitiveness of organizations, both in manufacturing industries and in service companies; however, the nature of these two areas is different,

and this difference highlights the need to use distinct analytical approaches. In manufacturing industries, data is mainly quantitative and measurable, and evaluating the efficiency of value chain activities with the classic TOPSIS method allows for accurate analysis, clear ranking, and identification of inefficient activities. This approach helps managers make targeted process improvement decisions based on real data.

In contrast, service companies face more uncertainty, subjective judgments, and qualitative criteria. For this reason, using fuzzy TOPSIS in prioritizing value chain improvement strategies allows for more accurate modeling of ambiguity and analysis of expert judgments. This approach allows service organizations to choose strategies that have the greatest impact on service quality, customer satisfaction, and value creation.

Finally, a comparison of the two papers shows that although both use the value chain framework and MCDM methods, the differences in the type of data, the nature of the activities, and the type of decision-making require different analytical approaches. The overall conclusion is that combining value chain analysis with multi-criteria decision-making methods—whether in the form of classic or fuzzy TOPSIS—can be a powerful tool for improving the performance of organizations in both manufacturing and service sectors.

Resources

1. Evaluating the Efficiency of Value Chain Activities in Manufacturing Industries Using the TOPSIS Method
2. Prioritizing Value Chain Improvement Strategies in Service Companies Using Fuzzy TOPSIS