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Development of a decision support system for selecting the location of chain stores using a combined AHP and TOPSIS approach based on interval intuitive fuzzy logic: A case study of Ofogh Kourosh stores

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ABSTRACT

Choosing the optimal location for chain stores is one of the strategic decisions in the retail industry that has a direct impact on profitability, customer access, and competitive advantage. The complexity of the criteria affecting this decision increases the need for decision support systems based on multi-criteria methods. In this study, an integrated decision support system for chain store location has been developed, which uses a combined approach of Analytic Hierarchy Process (AHP) and Ranking Technique Based on Similarity to Ideal Solution (TOPSIS) in an interval intuitive fuzzy logic environment. First, the weights of the criteria are determined using interval intuitive fuzzy AHP, and then the location options are evaluated and ranked using TOPSIS. The use of interval intuitive fuzzy logic allows modeling uncertainty, doubt, and subjective judgments of experts. A case study was conducted on the Ofogh Kourosh chain stores and the results show that the proposed model is able to make decisions more accurately, flexibly and more consistent with the actual market conditions. This approach can be used as an efficient tool for retail managers in developing the store network.

Problem Definition:

Choosing the right location for chain stores is one of the strategic and long-term decisions in the retail industry that has a direct impact on sales volume, customer access, operating costs, and competitive advantage. This decision is usually influenced by a set of quantitative and qualitative criteria, including population, traffic, competitors, rental costs, accessibility, and socio-economic characteristics of the area. The complexity of these criteria and the existence of uncertainty in human judgments make the location process a multi-criteria challenge that requires advanced analytical tools.

Multi-criteria decision-making methods such as AHP and TOPSIS have been widely used in recent years to solve location problems. However, these methods, in their classical form, are unable to fully model the uncertainty, hesitation, and ambiguity present in expert opinions. On the other hand, real-world retail decision-making environments, especially in dynamic and competitive markets, require approaches that can more accurately represent subjective judgments and incomplete information. Intuitive interval fuzzy logic allows for the analysis to include not only the degree of membership and non-membership, but also the degree of uncertainty.

Considering the rapid growth of the Ofogh Kourosh chain of stores and the need for this chain to select new locations with high accuracy and efficiency, the development of a decision support system based on the combined AHP and TOPSIS approach in an intuitive interval fuzzy environment seems necessary. This system can weight criteria and rank location options more accurately and help managers make decisions that are more consistent with real market conditions. The aim of the problem is to provide a model that can manage uncertainty and facilitate the selection of the optimal location for the development of the Ofogh Kourosh store network.

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:

-2-1Article One:

Main topic: Comparative analysis of AHP and TOPSIS methods in retail businesses Location selection decision support system

-2-1-1Classification based on the nature of decision making

The Multi-Criteria Decision Making (MCDM) problem of store location selection is a multi-criteria problem that includes quantitative and qualitative criteria such as population, rental cost, accessibility, competitors, and sales potential.

Strategic Decision-Making Problem The location of stores has a long-term impact on the performance and development of the network and is considered a type of strategic decision.

Uncertainty-Based Decision-Making Problem Human judgments, incomplete data, and changing market conditions place the problem in an environment of ambiguity and uncertainty.

-2-1-2Classification based on solution methods

Decision Hierarchy Process (AHP) methods for weighting criteria and analyzing the hierarchical structure of the decision.

Top-down Option Ranking and Selection (TOPSIS) methods for evaluating and ranking location options based on their distance from the ideal solution.

Fuzzy and interval intuitionistic approaches for modeling uncertainty, hesitation, and ambiguity in expert judgment.

Comparative Analysis approaches for evaluating the performance and efficiency of AHP and TOPSIS in the retail environment.

-2-1-3Classification by Application

Retail Business Focusing on chain stores and distribution networks.

Decision Support Systems (DSS) Developing an analytical tool to help managers select the optimal location.

Retail Location Selection Selecting the best locations for new store development with the aim of increasing profitability and customer reach.

2-2 Second article:

Main topic:

Location of retail chain stores using fuzzy AHP with integrated interval value and TOPSIS: A case study of Ofogh Kourosh stores

2-2-1Classification based on the nature and structure of decision-making

The multi-criteria decision-making (MCDM) problem is the selection of store location under the influence of a set of quantitative and qualitative criteria such as population, rental cost, competition, accessibility, and sales potential.

The decision-making problem under conditions of uncertainty (Uncertain Decision-Making) Human judgments, incomplete data, and changing market conditions create ambiguity and uncertainty in the decision-making process.

The long-term strategic location problem (Strategic Location Problem) The location of stores has a direct impact on network development, market share, and long-term profitability.

2-2-2-Classification based on solution methods and approaches

Criteria weighting hierarchical methods (Interval-valued fuzzy intuitionistic AHP) to determine the relative importance of criteria by considering membership, non-membership, and uncertainty in expert judgment.

Alternative ranking methods (Hybrid TOPSIS) to evaluate and select the best spatial option based on the distance from the positive and negative ideal solution.

Interval-Valued Intuitionistic Fuzzy approaches to model uncertainty, ambiguity, and human judgment domains in spatial data.

Hybrid MCDM Approach combining Intuitive Fuzzy AHP for weighting and TOPSIS for ranking options.

2-2-3-Classification based on application area and problem environment

Retail Chain Stores Focus on chain stores and distribution network development.

Decision Support Systems Development of a tool to help managers select optimal locations.

Retail Location Selection Selecting appropriate locations to increase sales, improve customer access, and reduce costs.

Case study of Ofogh Kourosh stores Application of the model in a real and large retail network in Iran.

Mathematical modeling:

3-1First article

-3-1-1Main components of the model

Option set: A set of potential locations for retail stores (e.g., multiple neighborhoods,

multiple urban points, or multiple shopping centers)

Criteria set: Includes quantitative and qualitative criteria such as: area population, purchasing power, rental cost, access to public transportation, distance from competitors, pedestrian traffic, security, future expandability.

Decision makers/experts: A group of managers, marketing experts, urban planners, or location specialists whose judgments are used to weight the criteria and evaluate the options.

Model output: Ranking of location options and selecting the best or several top options, separately with AHP and TOPSIS, and then comparing the results.

-3-1-2AHP model structure in this problem

Hierarchical structure:

First level: Macro-goal → Selecting the optimal location of the retail store.

Second level: Criteria and, if necessary, sub-criteria.

Third level: Location options.

2.Pairwise comparison of criteria:

Experts express the relative importance of both criteria to each other (for example, the importance of population to rental cost, the importance of competition to accessibility, etc.).

From these judgments, the relative importance of each criterion is extracted (criteria weight).

Evaluation of options relative to criteria:

Each location option is evaluated by experts relative to each criterion (for example, location A is “very good” in terms of population, “average” in terms of rental cost, etc.)

Finally, an overall score is obtained for each option and the options are ranked based on this score.

-3-1-3Structure of the TOPSIS model in this problem

Decision matrix:

Rows: Location options.

Columns: Criteria.

Each house: the performance of an option relative to a criterion (e.g. population, rent, accessibility, etc.).

Weighting the criteria:

The same weights obtained from AHP can be used (combined approach) or the weights can be determined separately.

Definition of ideal and anti-ideal solutions:

For each criterion, a “best-case” value (ideal) and a “worst-case” value (anti-ideal) are considered.

For example, for population, a high value is desirable; for rental costs, a low value is desirable.

Calculation of the proximity of each option to the ideal solution:

Each option is measured based on its distance from the ideal and anti-ideal.

The option that is closer to the ideal and further from the anti-ideal gets a higher rank.

-3-1-4Comparative layer (comparative analysis of AHP and TOPSIS)

In this section, the problem itself is seen as two parallel models:

Model 1: Location selection using AHP

Model 2: Location selection using TOPSIS (with the same data and criteria)

Then:

Comparison of rankings:

Checking whether both methods suggest an option as the best location or not.

Analyzing the degree of correlation between the rankings obtained from the two methods.
Sensitivity analysis:
Examining the effect of changing the weights of the criteria on the results of each method.
Examining which method is more stable to changes in expert judgment.
3.Interpretability and managerial applicability analysis:
Which method is more understandable and usable for retail managers?
Which method can better reflect uncertainty and subjective judgments (if using fuzzy or intuitive versions)?
-3-1-5Definition of the problem in the form of a decision model
Conceptually, the problem is that:

We have a set of location options.
We have a set of decision criteria that have different relative importance.
We want to use two analytical frameworks (AHP and TOPSIS)

Determine the importance of the criteria,
Evaluate the performance of the options,
Rank the options,
and finally compare the results of the two methods in terms of accuracy, stability, and compliance with management preferences.
3-2Second article:
-3-2-1Basic components of the model

Set of options: A set of potential locations for the construction or expansion of Ofogh Kourosh chain stores in a city or several cities. Each option is a specific location (e.g., neighborhood, shopping center, main street)
Set of criteria and sub-criteria: Includes the main criteria and, if necessary, sub-criteria, such as:

Population and population density
Purchasing power and income level
Rental cost and property price
Access to public transportation and parking
Distance from competitors and similar stores
Pedestrian and car traffic
Environmental safety and attractiveness
Possibility of future development and legal restrictions

Decision makers/experts: A group of Ofogh Kourosh managers, marketing experts, urban planners, and location specialists whose judgments are the basis of the model.
-3-2-2Intuitive Fuzzy AHP Layer with Interval Value
In this layer, the goal is to determine the weight of criteria and sub-criteria in an environment of uncertainty.

Hierarchical structure:

First level: Macro-goal → Select the optimal location of the Ofogh Kourosh store.
Second level: Main criteria (e.g. economic, demographic, accessibility, competitive, environmental)
Third level: Sub-criteria (e.g. economic criterion subset: rental cost, land price; demographic criterion subset: density, purchasing power, etc.)
Fourth level: Location options.

Intuitive Fuzzy Judgments with Interval Value:

Each pairwise comparison between criteria and sub-criteria is expressed by experts as a degree of preference.

These preferences are expressed not as a definite number, but as an interval and intuitive; That is, for each judgment,

- An interval for the degree of membership (preference level),
- An interval for the degree of non-membership (non-preference level),
- And an implicit uncertainty between these two are considered.

The output of this layer:

the final weight of each criterion and sub-criterion in the form of interval intuitive fuzzy weights.

These weights are later used in TOPSIS.

-3-2-3TOPSIS layer in interval intuitive fuzzy environment

In this layer, the goal is to rank the location options using the weights obtained from AHP.

Interval intuitive fuzzy decision matrix:

Rows: Location options (proposed points for Ofogh Kourosh store)

Columns: Criteria and sub-criteria.

Each house: Evaluation of the option against a criterion, as an interval fuzzy intuitionistic value (e.g. performance of a place in terms of "purchasing power" or "accessibility" with a membership interval, a non-membership interval and a hesitation interval)

Criteria weighting:

Weights obtained from the interval fuzzy intuitionistic AHP are applied to this matrix to take into account the relative importance of each criterion in evaluating the options.

Definition of the interval fuzzy intuitionistic ideal and anti-ideal solution:

For each criterion, a "best-case" and a "worst-case" situation are defined in the form of interval fuzzy intuitionistic values.

For benefit criteria (e.g. population, purchasing power), a higher value is more desirable.

For cost criteria (e.g. rent, land price), a lower value is more desirable.

Calculation of the proximity of each option to the ideal solution:

For each option, its proximity to the ideal solution and its distance from the anti-ideal are calculated (in the interval intuitionistic fuzzy space)

Finally, for each option, a "relative proximity" index to the ideal solution is obtained.

Output of this layer:

Final ranking of spatial options based on the relative proximity index.

The option with the highest index is the best proposed location for the construction or development of the Ofogh Kourosh store.

-4-2-3Decision variables, goal and logic of constraints

Decision variables:

Variables that indicate which option or options are chosen to select the location of the store (for example, choosing one or more locations from among the options).

It can be considered as a single-option (one location) or multiple-option (several locations) choice.

Model objective:

Maximizing spatial desirability based on the combination of criteria weights (from interval fuzzy intuitionistic AHP) and options performance (from interval fuzzy intuitionistic TOPSIS)

Conceptually: selecting the option that is closest to the ideal situation and closest to the anti-

ideal situation.

Constraints (conceptually):

Budget constraints (e.g., maximum acceptable cost for rent or purchase)

Limitation on the number of stores that can be opened in a period of time.

Spatial and legal constraints (e.g., inability to build in some areas).

Operational constraints (e.g., minimum or maximum distance between existing and new stores)

-5-2-3Placement of the Ofogh Kourosh case study in the model

Actual data:

Criteria and sub-criteria are defined based on the strategy and policies of Ofogh Kourosh.

Location options are selected from among real urban locations (e.g., different areas of Tehran or other cities)

Expert judgments are collected from managers and experts of Ofogh Kourosh.

Application of the model:

The model determines the weight of the criteria in accordance with the actual preferences of Ofogh Kourosh.

It ranks the location options based on the actual market conditions, competition and costs.

The output of the model can be used as a location decision support system in the development of Ofogh Kourosh's store network.

Problem solving method:

1-4First article:

In this research, the problem of selecting the location of retail stores is examined as a strategic and multi-criteria decision. This decision is influenced by a set of economic, demographic, competitive and accessibility factors and, due to the presence of qualitative data and subjective judgments, requires the use of structured analytical methods. The goal is to create a decision-making framework that can evaluate different criteria in a coherent manner and identify suitable locations for the development of the store network.

To solve The problem, the two methods AHP and TOPSIS are used in parallel to enable comparative analysis. In the AHP path, the hierarchical structure of the problem is defined and the relative importance of the criteria is determined through pairwise comparison. Then, the location options are evaluated and ranked based on the weights of the criteria. In the TOPSIS path, the decision matrix is formed and the options are ranked based on their proximity to the ideal solution and distance from the anti-ideal. Using the same data in both methods allows for a precise comparison of the results. In the final stage, the output of the two methods is compared in terms of ranking, sensitivity to changing criteria weights, and the degree of compatibility with management preferences. This comparison shows which method is more stable and which is more reliable for retail decision makers. The result of this process can be used as an operational decision support system and help managers choose the best locations for the development of chain stores.

4-2Second article:

In this problem, the goal is to select the best location for the development of the Ofogh Kourosh chain of stores; a decision that is influenced by a set of economic, demographic, competitive, and accessibility criteria. Due to the uncertainty in data and human judgments, an interval-valued fuzzy intuitionistic approach is used to make the assessments more realistic and closer to the actual conditions of the retail market. First, location options and decision-making criteria are identified, and the necessary data are collected through experts and field sources.

In the next step, the interval-valued fuzzy intuitionistic AHP method is used to determine the

weight of the criteria. Experts verbally express the relative importance of the criteria, and these judgments are converted into interval-valued fuzzy intuitionistic values to simultaneously model the degree of preference, dispreference, and hesitation. The output of this step is the final weight of the criteria, which indicates how important each factor is in choosing the store location. These weights are then used as input to the TOPSIS method.

In the final step, the interval-intuitive fuzzy TOPSIS method is used to rank the location options. The performance of each option relative to the criteria is evaluated in the form of interval-intuitive fuzzy values, and the degree of proximity of each option to the ideal situation and its distance from the anti-ideal situation is calculated. The result of this process is the final ranking of locations, which introduces the best option for the development of Ofogh Kourosh stores. This solution method provides a coherent and reliable framework for decision-making in complex environments with uncertainty.

Literature Review

5-1First article:

-5-1-1Literature Review

This study is based on the literature on multi-criteria decision-making and attempts to analyze two widely used methods, AHP and TOPSIS, in the field of retail store location. From the literature perspective, the topic contributes to the richness of MCDM research on the one hand and covers the gap in applied retail studies on the other. However, the existing literature shows that many studies have limited themselves to using only one method and have less focused on the structural and analytical comparison of the two methods. Therefore, this topic creates significant added value in terms of the research literature, but requires precision in model design and interpretation of results to go beyond the level of a simple comparison.

-5-1-2Strengths

Applicability of the topic: Retail store location is a real and vital issue for businesses, and the research results can be directly used in managerial decision-making.

The use of two valid and complementary methods: AHP for weighting criteria and TOPSIS for ranking options is a logical and accepted combination in the MCDM literature.

Comparability: Running both methods on a common data set allows for analyzing differences, similarities, and stability of results.

Transparency and interpretability: Both methods are understandable to non-specialist managers, and their output is presented in the form of clear rankings.

-3-1-5Weaknesses

Lack of deep modeling of uncertainty in the classical version: If fuzzy or intuitive versions are not used, both methods have limitations in dealing with ambiguous or subjective data.

Sensitivity of AHP to expert judgments: The smallest change in pairwise comparisons can change the weights, which may make the results unstable.

TOPSIS's dependence on normalization and scaling: The choice of normalization method can affect the final ranking, and this requires care.

Lack of consideration of the interaction of criteria: Both methods assume that the criteria are independent, while in reality, criteria such as population, purchasing power, and competitiveness are interdependent.

-4-1-5Future Research

Extending the model to intuitive or interval fuzzy versions: Using IVIF or IF-AHP and IF-TOPSIS can better model uncertainty and make the results more realistic.
Combining with artificial intelligence methods: Machine learning algorithms can be used for demand forecasting or competitor analysis and integrated with MCDM.
Using spatial data (GIS): Combining AHP/TOPSIS with GIS can increase the spatial accuracy of the model and enable spatial analysis.
Stability and scenario analysis: Examining the results under different economic conditions, demographic changes or competitive scenarios can make the model more applicable.
Comparison with newer MCDM methods: Methods such as VIKOR, COPRAS, BWM or MARCOS can be entered into the model in the future for a more comprehensive comparison.

2-5Second article:

-1-2-5Literature review

From the perspective of the research literature, this study is in line with efforts that seek to improve multi-criteria decision-making methods in real and complex environments. The literature shows that the classic versions of AHP and TOPSIS have limitations in dealing with ambiguous data, and the use of interval intuitionistic fuzzy is an important step in overcoming these limitations. However, the literature also emphasizes that hybrid models must be carefully examined in terms of stability, sensitivity, and consistency to go beyond the level of a simple combination. This study contributes to the richness of the applied literature by choosing a real case study, but still requires deeper analyses in the field of criteria interaction and market dynamics.

-2-2-5Strengths

Ability to model uncertainty: The use of interval intuitionistic fuzzy allows human judgments to be recorded more accurately and uncertainty and ambiguity are also taken into account in the model.
Powerful integrated approach: The combination of AHP for weighting and TOPSIS for ranking creates a coherent and valid structure that has an established place in the MCDM literature.
High applicability in the retail industry: The proposed model can be directly used in the development of the Ofogh Kourosh store network and other chain brands.
Suitable interpretability for managers: The model output is presented in the form of a clear ranking and is understandable even to non-specialist decision makers.

-3-2-5Weaknesses

High computational complexity: The use of intuitive fuzzy logic makes the calculation process more cumbersome and its implementation requires specialized software tools.
High dependence on expert judgment: The quality of the results depends on the accuracy and consistency of expert judgments, and any bias can change the weights.
Assumption of independence of criteria: Both AHP and TOPSIS methods assume that the criteria are independent, while in reality criteria such as population, purchasing power and competition are interdependent.
Model stationarity: The model does not dynamically consider the rapid changes in the retail market, the behavior of competitors and economic fluctuations.

-4-2-5Future Research

Integration with GIS for more accurate spatial analysis: Combining the model with geographic information systems can increase spatial accuracy and spatial analysis.
Use of modern MCDM methods: Methods such as BWM, MARCOS, VIKOR or COPRAS can be entered into the model for more comprehensive comparison.
Development of dynamic and scenario-based models: Adding advanced sensitivity analysis, economic scenarios and demand forecasting can make the model more realistic.
Combination with machine learning: Customer behavior prediction algorithms, competitor analysis and region clustering can make the model more intelligent.
Extension to other industries: This framework can also be used for locating bank branches, service centers, warehouses and hospitals.

Analysis Gap Table:

Comparison axis	**Article 1: Comparative Analysis of AHP and TOPSIS**	**Second article: Fuzzy Intuitive Interval AHP + TOPSIS (Ofq Kourosh)**	**Gap**
Type of methods	Classic version of AHP and TOPSIS	Fuzzy Intuitive Interval Version of AHP and TOPSIS	The first paper does not model uncertainty; the second paper covers this weakness
Level of model complexity	Simpler, based on definitive data	More complex, based on fuzzy intuitive data	The first paper lacks modeling of uncertainty and ambiguity
Type of data	Numerical data and definitive judgments	Linguistic, fuzzy, intuitive and interval data	The first paper is less suitable for the real retail environment
Practical application	General for retail businesses	Real case study (Ofq Kourosh)	The first paper lacks a real case study
Main objective	Comparison of the performance of two methods	Providing an advanced integrated model for location	The first paper does not provide a hybrid model
Level of decision-making	Analytical and comparative	Applied, operational and decision-oriented	The first paper does not have operational output
Uncertainty management	Does not compare rankings and analyze methods	(Fuzzy Intuitive Interval)	The first paper performs worse in real environments with ambiguity
Final output	Limited to comparison of methods	Choosing the best location for a store	The first paper does not provide an operational solution
Innovation	High but superficial	Innovation in fuzzy intuitive interval modeling	The first paper lacks computational innovation
Generalizability	Article 1: Comparative Analysis of AHP and TOPSIS	Moderate but accurate and practical	The second paper is more specialized and requires real data

Conclusion:

The combination of the two issues shows that the location of chain stores in the retail industry cannot be relied on by relying on only one decision-making method and requires an approach that has both analytical accuracy and can manage the ambiguity and uncertainty of the real environment. The first paper, by comparing the AHP and TOPSIS methods, clarifies the strengths and weaknesses of each method in real retail business conditions and shows that AHP is more suitable for weighting criteria, while TOPSIS performs better in ranking options. This analysis provides a basis for the second study to design an efficient integrated model.

In the second paper, this integrated approach is developed using interval-valued intuitive fuzzy AHP and TOPSIS and applied to a real case study (Ofogh Kourosh stores). The use of interval intuitive fuzzy logic has enabled the model to better represent human judgments, uncertainty, and ambiguity, and as a result, criteria weighting and option evaluation can be performed more accurately. Combining these weights with the TOPSIS ranking structure has created an operational and reliable decision-making framework.

Finally, the joint conclusion of these two studies shows that the best approach for retail store location is to use hybrid and fuzzy models; because classical methods alone are not able to manage the real complexities of the market. The proposed hybrid model is not only theoretically richer, but also practically able to meet the needs of a large brand like Ofogh Kourosh. This conclusion also clarifies the future direction of research: moving towards smarter, more fuzzy, and real-data-based models for strategic decision-making in the retail industry.

Resources

1. Comparative Analysis of AHP and TOPSIS Methods in Retail Business Location Selection Decision Support System
2. Retail Chain Stores Location using Integrated Interval Valued Intuitionistic Fuzzy AHP and TOPSIS: Case Study Ofogh Kourosh Stores