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# CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

# DEVELOPING A MULTI-CRITERIA DECISION-MAKING MODEL FOR INVESTMENT PROJECT SELECTION IN TEXTILE ENTERPRISES

**Jasurbek Pozilovich Qurbonov**
**Dean of the Faculty of Economics**
**Alfraganus University**
**ORCID: 0000-0003-2651-3392**
**E-mail: j.qurbonov@afu.uz.**

**Annotation.** This article develops a multi-criteria decision-making model for selecting investment projects in textile enterprises. The research integrates the Analytic Hierarchy Process, entropy weighting, TOPSIS, and fuzzy logic into a unified methodological framework for project evaluation. Financial, technological, operational, strategic, and sustainability criteria are systematically incorporated to support comprehensive investment assessment. The findings demonstrate that combining subjective expert judgments with objective project data improves the quality of investment decisions, promotes more efficient capital allocation, and strengthens the competitiveness of textile enterprises. Furthermore, the study substantiates the practical applicability of the proposed model and highlights its significance for enhancing investment management and supporting sustainable industrial development.

**Keywords:** textile enterprises, investment projects, multi-criteria decision making, Analytic Hierarchy Process, TOPSIS, entropy weighting, fuzzy logic, investments.

## INTRODUCTION

Textile manufacturing operates inside a deeply integrated and competitive global value chain, which makes the quality of a firm's capital decisions a direct determinant of its competitive position. World Trade Organization data reported for 2024 show how concentrated and dynamic the sector remains: a single leading producer accounted for about 43.3 per cent of world textile exports, up from 41.5 per cent a year earlier, and shipped textiles worth roughly 299 billion United States dollars over the year [1]. For an individual enterprise competing within this landscape, the practical question is rarely abstract. It is where to direct a limited investment budget among tangible options such as a new spinning or weaving line, a finishing and dyeing upgrade, an energy or water retrofit, automation of an assembly stage, or an expansion of capacity, when each option draws on the same scarce funds.

Choices of this kind are multi-attribute by nature. A candidate project carries an expected return, a payback period, and a capital requirement, but it also embodies a level of technological maturity, an effect on energy and water efficiency, an implication for product quality and flexibility, a degree of regulatory and environmental compliance, and a particular fit with the firm's market position. These attributes are measured in different units, some quantitative and some qualitative, and they frequently pull in opposing directions, so that no option is best on every front. Decision settings with exactly this structure are the natural domain of multi-criteria decision-making, whose methods have been mapped extensively for project and portfolio selection [2].

Treating investment project selection as a multi-criteria problem has proven productive across manufacturing and consumer-goods contexts, where managers rank competing initiatives against a structured set of criteria rather than a single financial figure [3]. Classical appraisal through net present value or the internal rate of return retains its value as a financial anchor; however, on its own it cannot adequately weigh strategic and sustainability dimensions that resist monetary expression. The Analytic Hierarchy Process addresses that limitation by converting expert judgment into consistent priority scales through structured pairwise comparisons [4].

Once criteria and their weights are established, alternatives still have to be ranked. Distance-based ranking through the Technique for Order of Preference by Similarity to the Ideal Solution provides that ordering by

INTERNATIONAL SCIENTIFIC ELECTRONIC JOURNAL

measuring how close each option is to an ideal profile and how far it is from an anti-ideal profile [5]. Because early-stage project information and expert opinion are often imprecise, expressed in words rather than exact figures, a fuzzy representation of judgments preserves the meaning of linguistic assessments instead of forcing them into false precision [6].

Building on these foundations, the present work designs a transparent and replicable evaluation model that an investment committee within a textile enterprise can apply to rank candidate projects. The model deliberately combines managerial preferences with the objective information already contained in project data, and it is positioned against documented practice rather than presented in isolation. The remainder of the article reviews the relevant literature, sets out the methodology of the integrated model, examines its analytical properties and practical suitability for textile enterprises, and concludes with findings and recommendations.

## LITERATURE REVIEW

Applications of multi-criteria methods within the textile and apparel sector are both numerous and instructive. Facility location for a textile company has been addressed by comparing the Fuzzy Analytic Hierarchy Process and Fuzzy TOPSIS, a study that clarified how the two approaches handle a strategic siting decision under imprecise criteria [7]. Technology and supplier selection in the high-functionality textile segment has been examined using the Analytic Hierarchy Process and the Fuzzy Analytic Hierarchy Process, where supply chain considerations were found to outweigh the narrow technical merits of competing technologies [8]. Supplier selection in the garment industry has likewise been addressed using Fuzzy TOPSIS under linguistic evaluation, which accommodates the qualitative nature of buyer judgments [9].

Sustainability has become a structural part of these evaluations rather than an afterthought. An integrated Analytic Hierarchy Process and TOPSIS model for sustainable supplier selection in apparel balances economic, environmental, and social criteria while reflecting the views of both customers and expert managers [10]. Risk in the implementation of green supply chains in textiles has been assessed through a Fuzzy Analytic Hierarchy Process and TOPSIS framework that identified the sourcing of sustainable suppliers and the adoption of sustainable technology as the dominant risk factors [11]. Supplier selection in the fashion industry has been validated using a Fuzzy TOPSIS model informed directly by company managers [12].

Beyond textiles, investment-oriented multi-criteria research offers a transferable framework. The ranking of investment risk in high-technology projects has been carried out using TOPSIS in a fuzzy environment built on linguistic variables, which is well suited to the uncertainty of forward-looking estimates [13]. Venture capital selection has been modelled by combining TOPSIS with prospect theory so that the behavioural disposition of decision-makers enters the evaluation rather than being assumed away [14]. Broader reviews of sustainable manufacturing confirm that criteria sets are expanding to incorporate environmental and social dimensions alongside cost and performance [15].

Taken together, these contributions reveal a consistent division of labour. The Analytic Hierarchy Process provides criteria weights, TOPSIS provides a defensible ranking, and fuzzy logic accommodates the imprecision of human judgment. Two patterns also become evident. Most textile studies concentrate on supplier, technology, or location decisions rather than on enterprise-level selection among competing capital projects, and many rely solely on subjective weights. The resulting research opportunity is an integrated enterprise-level model that supplements managerial preferences with objective weighting derived from the project data themselves, which is the approach developed in the next section.

## RESEARCH METHODOLOGY

The proposed model integrates three established techniques behind a fuzzy front end. The Analytic Hierarchy Process organises the decision, the entropy method contributes objective weights, and TOPSIS produces the final ranking. Following the hierarchical logic of the Analytic Hierarchy Process, the problem is arranged into three layers: an overall goal, a set of evaluation criteria, and the candidate projects to be compared [4].

## CRITERIA STRUCTURE

The evaluation criteria are grouped into five families that reflect documented practice in manufacturing and textile decision-making. The financial family covers expected return, payback period, and the capital requirement of a project. The technological family covers technological maturity, compatibility with existing equipment, and the degree of automation. The operational family covers capacity expansion, flexibility, and reliability. The market and strategic family covers market demand fit, competitiveness, and alignment with the firm’s strategic direction. The sustainability family covers energy and water efficiency, emissions, and regulatory compliance, whose inclusion is now standard in manufacturing evaluations [15] and is especially salient in textile supply chains [8]. Keeping these families explicit ensures that a strong financial case cannot quietly override environmental or strategic considerations.

*Subjective weighting through the analytic hierarchy process*

Experts compare the criteria pairwise using Saaty's fundamental nine-point scale, and the priority vector is derived as the normalized principal eigenvector of the resulting pairwise comparison matrix. The consistency of expert judgments is evaluated using the Consistency Index (CI) and the Consistency Ratio (CR). The Consistency Index is calculated as:

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

while the Consistency Ratio is determined by:

$$CR = \frac{CI}{RI}$$

where is $\lambda_{max}$ the maximum eigenvalue of the pairwise comparison matrix, is the number of evaluation criteria, and is the Random Index. A Consistency Ratio (CR) below 0.10 is generally accepted as evidence of consistent and reliable expert judgments [4]. Applying this threshold ensures that the subjective component of the evaluation remains systematic and controlled, thereby improving the credibility and robustness of the weighting process.

*Fuzzy treatment of imprecise judgments*

Linguistic ratings such as "high", "medium" or "low" are represented as triangular fuzzy numbers, each defined by a lower, a modal and an upper value, so that the natural vagueness of expert language is retained rather than discarded [6]. The fuzzy assessments are aggregated across the expert panel and defuzzified into crisp performance values before the ranking stage, which lets the model honour qualitative nuance while still yielding an unambiguous order at the end.

*Objective weighting through entropy*

Entropy weighting derives the importance of a criterion from the dispersion of values that the projects actually display on it. The decision matrix is first normalised, the entropy e_j of each criterion is computed from the normalised values, the degree of diversification is taken as d_j = 1 − e_j, and the objective weight follows as w_j = d_j / Σ d_j. A criterion on which the projects differ markedly receives more weight, because it discriminates between them, while a criterion on which they are nearly identical receives less. Coupling this objective signal with distance-based ranking has been shown to strengthen the robustness of the outcome [16].

*Combined weighting*

The subjective weights from the analytic hierarchy process and the objective weights from entropy are merged into a single composite weight vector, in line with hybrid practice that draws on both sources of information [17]. The combination guards against two opposite failures: a criterion that managers prize but that fails to separate the projects does not dominate, and a criterion on which the projects differ sharply but which carries little strategic meaning does not take over. Because entropy is among the most widely used objective methods, its role as a complement to managerial weighting is well established [18], and the balance it brings reduces dependence on any single source of judgment.

*Ranking through TOPSIS*

With composite weights in hand, the weighted normalised decision matrix is formed, after which the positive ideal solution is assembled from the best value of each criterion and the negative ideal solution from the worst. The separation of each project from these two reference profiles is measured by Euclidean distance, giving d_i^+ and d_i^−, and the relative closeness coefficient is computed as C_i = d_i^− / (d_i^+ + d_i^−), with values closer to one indicating a more attractive project [5]. Ranking the projects in descending order of C_i yields the recommended priority list. The formulas above describe the mechanics of the model; they are not applied here to invented data, since the contribution of the work is the structure itself.

## ANALYSIS AND RESULTS

The integrated structure is summarised in Figure 1, which places the decision hierarchy alongside the evaluation pipeline. Panel A arranges the goal, the five criteria families, and the candidate projects in the layered form required by the Analytic Hierarchy Process [4]. Panel B traces the computational flow: the problem is structured, subjective and objective weights are generated in parallel, the two are combined into integrated weights, fuzzy evaluation accommodates the imprecision of expert ratings, and TOPSIS converts the weighted assessments into an ordered ranking [5] (Figure 1).

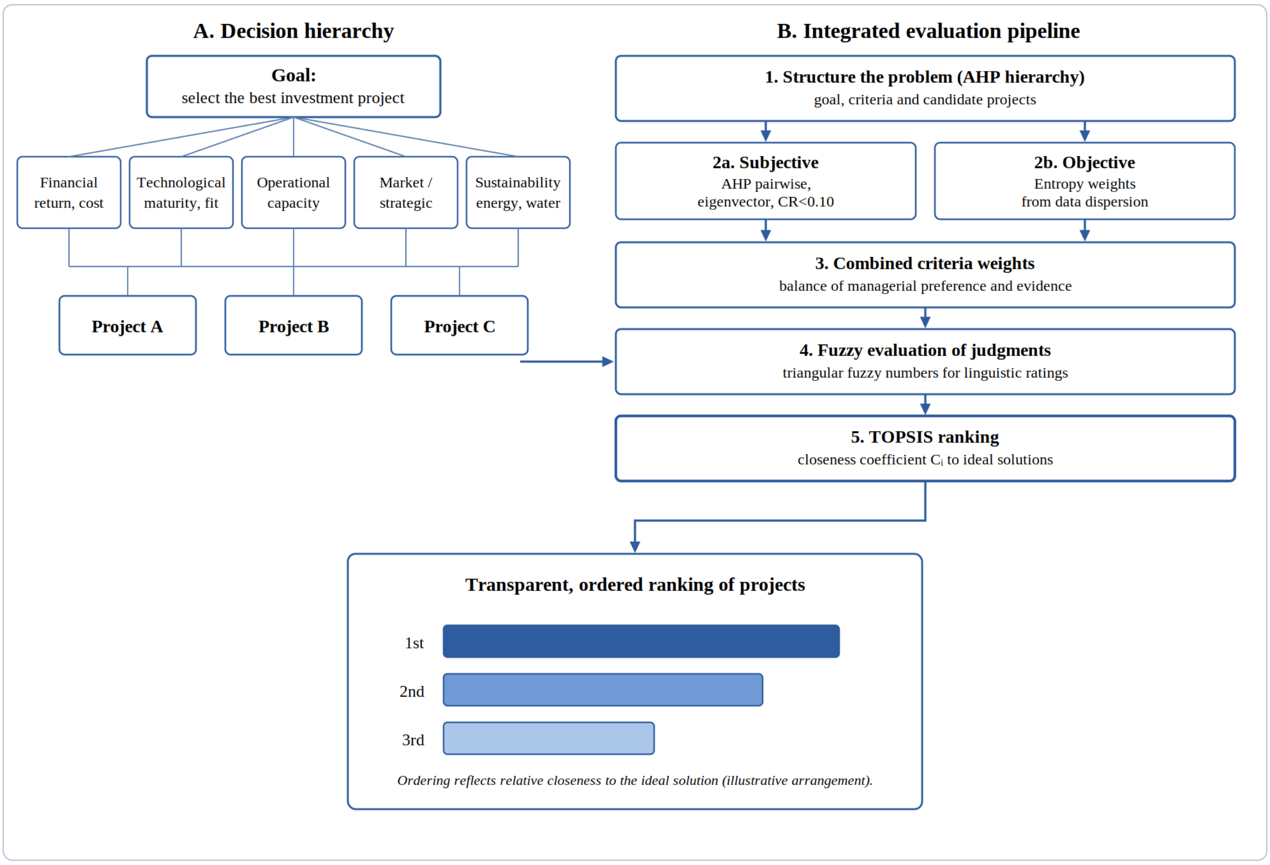


**Figure 1. Conceptual framework of the proposed integrated model for investment project selection in textile enterprises, combining the analytic hierarchy process, entropy weighting, fuzzy evaluation and TOPSIS[1].**

Each component of the framework plays a defined and complementary role, as summarised in Table 1, together with its supporting source. The table makes the internal logic transparent and auditable: every block in the evaluation pipeline corresponds to a documented method, and no element is introduced without methodological justification (Table 1).

Table 1.
Components of the proposed model, their function and their sources.

| Component | Function within the proposed model | Source |
|---|---|---|
| Analytic hierarchy process (AHP) | Structures the goal, criteria and alternatives, and derives subjective criteria weights through pairwise comparison with a consistency check. | [4] |
| TOPSIS | Ranks alternatives by their relative closeness to the positive and negative ideal solutions. | [5] |
| Fuzzy representation | Captures linguistic, imprecise expert ratings through membership functions before aggregation. | [6] |
| Entropy weighting | Provides objective weights from the dispersion of values that the projects actually exhibit on each criterion. | [16] |
| Combined weighting | Reconciles AHP-based preference with entropy-based evidence into a single composite weight vector. | [17] |
| Objective-subjective balance | Positions entropy among the most used objective methods complementing managerial weighting. | [18] |

1 Author's work

Analytical properties

The chief analytical merit of the model lies in how it reconciles two kinds of information that single-method studies tend to keep apart. The Analytic Hierarchy Process guarantees that the strategic priorities of management enter the evaluation explicitly and that their internal coherence is verified through the consistency ratio [4]. Entropy weighting, by contrast, listens to the data: it raises the influence of criteria on which the projects genuinely diverge and lowers the influence of criteria on which they barely differ [16]. Merging the two produces weights that are neither blind to managerial intent nor detached from the evidence contained in the project portfolio.

Interpretability is a further strength. The closeness coefficient produced by TOPSIS lies between zero and one, which gives decision-makers an intuitive measure of how near each project stands to the ideal profile and supports a clear, ordered recommendation [5]. The fuzzy front end protects the meaning of qualitative assessments, allowing a panel to express judgments in natural language while the model still returns a definite ranking [6]. Together, these features make the reasoning behind a recommendation visible and defensible, which matters when an investment committee must justify the allocation of substantial capital.

Comparative behaviour

Comparative examinations of multi-criteria methods report that rankings can shift with the chosen weighting scheme and normalisation procedure, which is precisely why a model that blends subjective and objective weights and incorporates sensitivity analysis tends to deliver steadier conclusions than a single-method alternative [19]. By drawing on two independent weighting sources, the proposed structure reduces the sensitivity of the final ranking to any single source and provides a natural framework for testing the robustness of a recommendation before implementation.

Practical fit for textile enterprises

The model maps cleanly onto the way a textile firm actually makes investment decisions. It corresponds to a decision-support procedure of the kind proposed for selecting manufacturing technologies and investment alternatives, where a structured set of criteria guides the comparison of competing options [20]. An investment committee can adopt the five criteria families as a standard template, gather the project data required for entropy weighting, convene an expert panel whose judgments are checked for consistency, and interpret the resulting closeness coefficients as a ranked basis for investment decisions. The criteria families also accommodate the distinctive concerns of textile production, where energy and water efficiency, emissions, and regulatory compliance are considered alongside capacity and flexibility [15], and where supply-chain and sustainability factors carry particular weight [11]. The design properties of the model—transparency, auditability, support for consensus, and alignment of capital allocation with both strategic and sustainability objectives—follow from its structure and are presented as conceptual characteristics rather than measured outcomes, thereby keeping the contribution firmly conceptual.

## CONCLUSIONS AND RECOMMENDATIONS

The work set out an integrated multi-criteria model for investment project selection in textile enterprises that combines the Analytic Hierarchy Process, entropy weighting, and TOPSIS within a fuzzy framework for handling imprecise judgments. Its defining feature is the reconciliation of subjective managerial preferences with objective evidence derived from project data, achieved through a transparent and replicable structure that yields an interpretable ranking of competing alternatives.

Several recommendations follow for practice. A textile firm benefits from maintaining a standard criteria hierarchy across the financial, technological, operational, market, and sustainability families so that successive investment rounds are evaluated on a consistent basis. Collecting structured project data in advance enables the entropy-weighting stage and keeps the objective weights well grounded. Expert panels should work with the nine-point comparison scale, with the consistency ratio enforced, and every recommendation should be accompanied by a sensitivity analysis. The weights should be revised periodically as markets and sustainability standards evolve [15], and the model is best used to complement existing financial appraisal rather than replace it [3].

Productive avenues remain for future work. Empirical validation using real enterprise data would test the model against observed decisions, while extensions employing interval or Pythagorean fuzzy sets would broaden its capacity to handle uncertainty. Comparisons with alternative ranking methods and group decision-making aggregation schemes would further strengthen confidence in the results. As textile enterprises continue to modernise their technological base and deepen their sustainability commitments, a decision model that makes capital allocation transparent, consistent, and evidence-based offers a constructive and durable contribution to the sector’s advancement.

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