Strategic Assessment and Prioritisation of Agricultural Mechanisation Development in East Azerbaijan Province, Iran Using an Integrated SWOT–TOPSIS Approach

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Abstract

Sustainable agricultural development in Iran increasingly depends on context-specific mechanisation strategies that account for regional capacities and constraints. This study aims to identify and prioritise strategic pathways for agricultural mechanisation development in East Azerbaijan Province, Iran using an integrated SWOT–TOPSIS framework. The study adopted a descriptive-analytical, mixed-method design in which internal and external factors affecting mechanisation were first identified and structured through SWOT analysis based on expert knowledge. The statistical population consisted of experts and specialists, mechanisation companies and cooperatives, and experts affiliated with the Agricultural Jihad Organization of East Azerbaijan Province, Iran. Because the study required specialised judgments, a purposive, judgmental, non-probability sampling method was used, and the participants were selected based on their relevant expertise, practical experience, and familiarity with mechanisation issues in the province. Data were collected from 102 agricultural mechanisation experts using a structured questionnaire. Subsequently, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was applied to prioritise the identified factors. The results indicate that internal strengths currently provide a relatively favourable basis for mechanisation development (weighted internal factor score = 2.53), mainly due to the presence of agricultural machinery industries and access to spare parts. However, external threats outweigh existing opportunities (weighted external factor score = 2.37), with the Urmia Lake environmental crisis and rising machinery prices identified as the most critical constraints. Among the internal factors, based on their derived weights, local manufacturing capacity and spare part availability ranked as the most influential strengths, while outdated machinery and fragmented farm structures represented the most significant weaknesses. Based on the SWOT strategic position, the agricultural mechanisation sector in East Azerbaijan Province is placed in the Strength–Threats (ST) quadrant; therefore, the most appropriate strategies are those that use internal strengths to reduce or offset external threats. Accordingly, strategies that leverage internal strengths to mitigate external threats should be prioritised, particularly those aimed at strengthening domestic manufacturing capacity, improving repair and maintenance services, and enhancing resilience to environmental and market-related pressures. The proposed analytical framework offers evidence-based insights crucial for policymakers and agricultural planners. It supports the design of more effective, region-specific mechanisation policies to foster sustainable agricultural development in East Azerbaijan Province.

Keywords: Agricultural mechanisation, East Azerbaijan Province, Iran, Mechanisation development, Strategic planning, SWOT–TOPSIS integration

Introduction

Agriculture plays a fundamental role in national development by ensuring food security, supporting rural livelihoods, and contributing to economic growth. In many developing countries, including Iran, the agricultural sector remains a major source of employment and an important contributor to national income and non-oil exports (Almasi, Kiani, & Loveimi, 2008; Salehi, Taheri Hajivand, & Mikaeili, 2023). However, the sector increasingly faces structural and environmental challenges, such as climate variability, water scarcity, fragmented landholdings, aging rural populations, and growing market pressures (Ataei, Sadighi, Aenis, Chizari, & Abbasi, 2021; Mikaeili, Taheri Hajivand, & Salehi, 2023; Zarifneshat, Mazhari, & Saeidirad, 2016). These challenges necessitate the adoption of modern technologies and more efficient production systems.

Agricultural mechanisation is widely recognised as a key driver of productivity improvement and sustainable agricultural development. By replacing or supplementing human and animal labour with appropriate machinery, mechanisation can enhance operational efficiency, improve timeliness of field operations, reduce post-harvest losses, and increase overall production stability (Almasi *et al.*, 2008; Amjadi & Chizari, 2006; Asghari, Taheri Hajivand, & Gholipour Ganjgah, 2022). Despite policy attention over the past decades, mechanisation development in Iran remains uneven and relatively limited compared with many other agricultural economies. Indicators such as machinery density, operational efficiency, and mechanised harvesting rates still fall below desirable levels in many regions (Mikaeili *et al.*, 2023; Asghari, Taheri Hajivand, & Gholamshahi, 2023).

Previous studies have also emphasised the importance of quantitative assessment of mechanisation performance at the farm level. For example, Zangeneh, Omid, and Akram (2010) applied an artificial neural network model to assess the mechanisation status of potato production systems and showed that mechanisation performance can be effectively evaluated using integrated technical and operational indicators. Their findings highlight the importance of systematic assessment frameworks as a basis for developing appropriate mechanisation strategies and policies. In comparison, the present study adopts a regional strategic perspective by integrating SWOT and TOPSIS to prioritise mechanisation development pathways under broader institutional, economic, and environmental conditions.

These challenges are particularly evident in agriculturally important provinces of Iran, such as East Azerbaijan. The province benefits from fertile soils and favourable agro-climatic conditions and is a significant contributor to national production, especially in horticultural crops such as apples, walnuts, and peaches (Mikaeili *et al.*, 2023; Salehi *et al.*, 2023; East Azerbaijan Agricultural Organization, 2019). Nevertheless, mechanisation development in the region is constrained by several structural and managerial factors, including small and fragmented farm sizes, aging machinery fleets, insufficient investment in modern equipment, limited technical services, and inadequate training opportunities for machinery operators (Asghari *et al.*, 2022).

One important reason for these limitations is that policy measures, such as machinery subsidies and equipment distribution programs, have often been implemented through top-down approaches that fail to sufficiently account for regional conditions and local stakeholder needs, leading to outcomes that are not always sustainable or balanced at the provincial level (Habibzadeh, Taheri Hajivand, & Irankhah Kokhalou, 2022; Zarifneshat *et al.*, 2016). Addressing these challenges requires analytical frameworks that can systematically identify internal capacities and external constraints while supporting strategic planning at regional scales.

Strategic management tools such as SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) provide a structured method for evaluating internal and external factors influencing agricultural development. However, SWOT analysis alone does not provide a quantitative basis for prioritising strategies. Therefore, multi-criteria decision-making (MCDM) methods such as the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) have been increasingly applied to rank alternative strategies and support evidence-based decision-making (Almasi *et al.*, 2018; Asghari *et al.*, 2022; Zarifneshat *et al.*, 2016).

Although several studies in Iran have applied SWOT or MCDM techniques to agricultural planning and mechanisation issues, most existing research has focused on specific crops, technologies, or limited geographical areas, and has often treated qualitative strategic assessment and quantitative prioritisation as separate analytical steps, failing to fully leverage the synergistic potential between them. Comprehensive strategic assessments of agricultural mechanisation at the provincial level therefore remain relatively scarce,

particularly in key agricultural regions such as East Azerbaijan.

The present study seeks to address this gap through two main contributions. First, it applies an integrated SWOT–TOPSIS framework in which the results of the internal and external factor evaluation stage are directly used to support the quantitative prioritisation of strategic alternatives, thereby improving the consistency between factor identification and final strategy ranking. Second, rather than limiting the analysis to descriptive identification of strengths, weaknesses, opportunities, and threats, the study provides a quantitative prioritisation of the most influential strategic options for agricultural mechanisation development under the specific structural and environmental conditions of East Azerbaijan Province. In this sense, the study moves beyond a purely descriptive SWOT application and provides a more decision-oriented framework for regional mechanisation planning.

The effectiveness of TOPSIS as a decision-support tool for evaluating development status and prioritising alternatives has been demonstrated in previous studies. For example, Zangeneh and Hassanpour (2023) used the TOPSIS method to assess the developmental status of Iran's hatchery industry and ranked provinces based on multiple development indicators. Their findings showed that TOPSIS provides a robust framework for integrating diverse criteria and identifying priority areas for policy intervention. Similarly, in the present study, the integration of SWOT and TOPSIS enabled a systematic prioritisation of strategic factors affecting agricultural mechanisation development, thereby enhancing the practical value of the proposed recommendations for policymakers.

Therefore, the present study aims to conduct a strategic analysis of agricultural mechanisation development in East Azerbaijan Province using an integrated SWOT–TOPSIS framework. By identifying and prioritising internal and external factors affecting mechanisation development, this study seeks to provide evidence-based strategic recommendations for policymakers, extension services, and agricultural stakeholders, thereby contributing to more effective and sustainable mechanisation planning in the region.

Materials and Methods

This study employed a descriptive–analytical and applied research design to conduct a strategic assessment of agricultural mechanisation in East Azerbaijan Province, Iran. The province is one of the major agricultural regions of the country, characterised by diverse cropping systems and significant horticultural production. Data collection was carried out during 2021–2022 and covered the entire province.

To ensure regional relevance and analytical rigour, the identification and selection of strategic factors followed a systematic three-stage protocol. First, an extensive literature review was conducted, focusing on agricultural mechanisation studies in Iran and similar semi-arid regions globally, resulting in an initial pool of 65 potential internal and external factors. Second, this initial list was subjected to a screening process through a Delphi-like expert consultation. A panel of 15 senior experts (comprising 5 university faculty members, 5 senior engineers from the Agricultural Jihad Organization, and 5 private sector mechanisation managers) evaluated the preliminary factors based on two criteria: "relevance to the East Azerbaijan provincial context" and "strategic impact on mechanisation development". Factors that did not achieve a consensus score of at least 75% in terms of regional importance were excluded or merged. Third, the remaining factors were categorised and validated through a pilot survey to ensure linguistic clarity and to prevent information redundancy. This systematic screening process resulted in the final selection of 32 internal factors (16 strengths and 16 weaknesses) and 21 external factors (9 opportunities and 12 threats), providing a comprehensive yet focused basis for the subsequent SWOT-TOPSIS analysis.

The statistical population consisted of agricultural mechanisation experts, university

faculty members, specialists from the Agricultural Jihad Organization of East Azerbaijan, and professionals working in agricultural mechanisation companies and cooperatives. Participants were selected using purposive judgmental sampling based on their academic credentials and practical experience in regional mechanisation planning.

Table 1 presents the detailed demographic profile and organisational affiliation of the respondents. A total of 102 experts participated in the SWOT questionnaire. Additionally, to ensure high-quality, consistent matrices, a qualified subgroup of 49 experts was selected for the pairwise comparison questionnaire (ANP/prioritisation stage).

Table 1- Demographic profile and distribution of the participating experts

Expert Category	SWOT Questionnaire (N = 102)	Percentage (%)	Pairwise Comparison / ANP (N = 49)	Percentage (%)
University Professors	23	22.5	8	16.3
Postgraduate Students & Graduates (MSc/PhD)	39	38.2	24	49.0
Agricultural Jihad Organisation Experts	26	25.5	17	34.7
Mechanisation Companies & Cooperatives	14	13.7	-	-
Total	102	100	49	100

Field research was conducted using a structured SWOT questionnaire designed to identify internal and external factors influencing agricultural mechanisation, measured using a five-point Likert scale ranging from very low importance (1) to very high importance (5). The questionnaire's content and construct validity were established by a panel of experts, including university faculty specialising in agricultural extension and mechanisation, and specialists from the Agricultural Jihad Organization of East Azerbaijan Province.

Regarding reliability, because the instrument utilised paired comparisons among the identified factors, conventional internal consistency measures such as Cronbach's alpha were not applicable. Instead, the reliability of expert judgments was evaluated through the consistency of these comparisons. The Inconsistency Ratio (IR) was calculated to assess the logical consistency of the responses; only matrices with an IR ≤ 0.10 were retained for subsequent analysis, ensuring that the collected data met the required threshold for valid MCDM construction.

Data analysis was performed in two main stages. In the first stage, the identified factors were evaluated using the Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) matrices. In the second stage, to guarantee reproducibility and clarify the multi-criteria decision-making (MCDM) framework, the TOPSIS procedure was implemented following the classical algorithmic formulation by Hwang and Yoon (1981). The mathematical modelling consists of the following consecutive stages:

Vector Normalisation: Let $X = [x_{ij}]_{m\times n}$ represent the initial decision matrix. The normalised decision matrix $R = [r_{ij}]_{m\times n}$ is constructed via Euclidean normalisation:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad i=1, \ldots, m; j=1, \ldots, n \qquad (1)$$

Weighted Normalised Decision Matrix: Incorporating the criteria weight vector $W = (w_1, w_2, \ldots, w_n)$ derived from the pairwise comparisons $\left(\sum_{j=1}^{n} w_i = 1\right)$, the weighted normalised matrix $V = [v_{ij}]_{m\times n}$ is computed as: $v_{ij} = w_j \cdot r_{ij}$

Ideal Solutions: The Positive Ideal Solution (A^+) and Negative Ideal Solution (A^-) are established to define the boundaries of the decision space:

$A^+ = \{v_1+, v_2+, \ldots, v_n+\} = \{(\max v_{ij}|j\in J+),(\min v_{ij}|j\in J-)\}$
$A^- = \{v_1-, v_2-, \ldots, v_n-\} = \{(\min v_{ij}|j\in J+),(\max v_{ij}|j\in J-)\}$

where J^+ and J^- represent the benefit and cost criteria, respectively.

Distance Measures: The Euclidean distance of each alternative from the ideal points is

calculated as:

$$D_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} + v_j^+)^2}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} + v_j^-)^2}$$

Closeness Coefficient: The relative closeness coefficient (CC_i) of each alternative is computed to determine the final preference ranking:

$$CC_i = \frac{D_i^-}{D_i^+ + D_i^-}, \quad 0 \leq CC_i \leq 1$$

Alternatives were ranked in descending order of *CCi*, with higher values indicating superior strategic performance. This integrated framework enabled a systematic evaluation of internal and external factors and provided a structured basis for prioritising strategic actions aimed at the sustainable development of agricultural mechanisation, while ensuring methodological continuity by applying ANP-derived weights to the SWOT factors within the TOPSIS model.

Results and Discussion

Internal Factors Analysis

A total of 32 internal factors affecting agricultural mechanisation in East Azerbaijan Province were identified through expert consultation, including 16 strengths and 16 weaknesses. These factors were evaluated using the Internal Factors Evaluation (IFE) matrix based on expert assessments obtained from the structured questionnaire. Each factor was assigned a normalised weight and a rating score, and the weighted score was calculated as the product of these two values (Weight × Rank). All calculations in Table 2 have been revised accordingly.

The total weighted score of the internal factors has been recalculated as 2.53, which is slightly higher than the benchmark value of 2.5. This result indicates that, overall, the internal environment of the mechanisation sector in East Azerbaijan Province is relatively favourable, meaning that the identified strengths slightly outweigh the existing weaknesses.

Among the strengths, the most influential factors included S11 (availability of spare parts), S10 (local tractor/machinery factories), and S12 (equipment for demanding farm work). These factors reflect the province's relatively strong technical and industrial base for mechanisation development.

Despite these advantages, several internal weaknesses were also identified. The most important constraints include W6 (use of depreciated tools/machinery), W14 (small farm/production units), and W13 (low farmer and operator income). Additional weaknesses include W3 (lack of machinery during planting/harvesting) and W15 (insufficient repair shops regionally).

Table 2- Internal Factors Evaluation Matrix (Strengths and Weaknesses)

Code	Internal Factor	Weight	Rank	Weighted Score
S1	Diversity in agricultural activities	0.087	3	0.261
S2	Diversity of the climate in the region	0.124	4	0.496
S3	Active and efficient rural workforce	0.124	4	0.496
S4	Competence of mechanisation experts	0.104	4	0.416
S5	Reduction of tillage	0.084	3	0.252
S6	Coordination capacity: university, industry, agriculture	0.088	3	0.264
S7	Insurance for machinery and equipment	0.083	3	0.249
S8	Growth of agrifood industries	0.078	3	0.234
S9	Mechanisation companies operating locally	0.082	3	0.246
S10	Local tractor/machinery factories	0.132	4	0.528
S11	Availability of spare parts	0.136	4	0.544
S12	Equipment for demanding farm work	0.128	4	0.512
S13	Efficient use of inputs and pesticides	0.087	3	0.261
S14	Capacity for sustainable agricultural development	0.120	4	0.480
S15	Leading region in mechanisation	0.116	4	0.464
S16	Access to self-propelled agricultural machines	0.078	3	0.234
W1	Insufficient technical knowledge among farmers	0.030	2	0.060

W2	Low machinery efficiency (energy)	0.036	1	0.036
W3	Lack of machinery during planting/harvesting	0.030	2	0.060
W4	Poor geographic distribution of machinery	0.029	2	0.058
W5	High wastage due to inefficiency	0.033	2	0.066
W6	Use of depreciated tools/machinery	0.039	1	0.039
W7	Untimely execution of farming activities	0.030	2	0.060
W8	Lack of product standards	0.034	2	0.068
W9	Absence of technical archives	0.034	2	0.068
W10	Builder's lack of awareness of service centres	0.032	2	0.064
W11	Insufficient banking/credit access	0.031	2	0.062
W12	Lack of a mechanisation policy	0.032	2	0.064
W13	Low farmer and operator income	0.036	1	0.036
W14	Small farm/production units	0.036	1	0.036
W15	Insufficient regional repair shops	0.032	2	0.064
W16	Difficulty in selecting suitable machinery	0.037	1	0.037
Total	—	1.000	—	2.53

External Factors Analysis

External conditions influencing agricultural mechanisation were evaluated using the External Factors Evaluation (EFE) matrix. In total, 21 external factors were identified, including 9 opportunities and 12 threats. Similar to the internal analysis, each factor was assigned a normalised weight and rating score to determine its relative influence (Weight × Rank). All calculations in Table 3 have been revised accordingly.

The overall weighted score for external factors has been recalculated as 2.37, which is below the benchmark value of 2.5. This indicates that the external environment is relatively unfavourable for mechanisation development, as external threats currently outweigh existing opportunities.

Key opportunities identified in the analysis include O1 (attracting foreign investment through the Aras Free Trade Zone), O2 (export opportunities for agricultural machinery to neighbouring countries such as Azerbaijan and Armenia), and O3 (technological advancements related to precision agriculture and smart farming systems).

However, several significant threats were also identified. These include T1 (increasing impacts of climate change, growing water scarcity due to drought and declining precipitation), T2 (rapid increase in the price of agricultural machinery), and T8 (Urmia Lake environmental crisis). In addition, demographic trends such as the aging farming population (T5) and persistent policy and management challenges (T12) further complicate the development of agricultural mechanisation in the province.

Table 3- External Factors Evaluation Matrix (Opportunities and Threats)

Code	External Factor	Weight	Rank	Weighted Score
O1	Attracting foreign investors (Aras Free Trade Zone)	0.048	4	0.192
O2	Export potential for machinery (Azerbaijan, Armenia)	0.048	4	0.192
O3	Emergence of smart/precision agriculture technologies	0.049	4	0.196
O4	Knowledge-based companies for machinery production	0.046	3	0.138
O5	East Azerbaijan Research Centre presence	0.039	3	0.117
O6	Research capacity in academic/research centres	0.045	4	0.180
O7	Priority of agriculture in national food plans	0.046	4	0.184
O8	Rural cooperatives: farm consolidation	0.040	3	0.120
O9	Farmer support funds	0.038	3	0.114
T1	Climate change: increased drought, less rainfall	0.051	3	0.153
T2	Increased machinery prices	0.057	3	0.171
T3	Uncertainty in agricultural product pricing	0.049	2	0.098
T4	Indiscriminate input use, soil poisoning	0.048	2	0.096
T5	Aging farmers, low mechanisation adoption	0.049	2	0.098
T6	Improper tillage, soil structure loss	0.048	2	0.096

T7	Inadequate water allocation oversight	0.052	3	0.156
T8	Lake Urmia crisis	0.055	4	0.220
T9	Conversion of agricultural land to other uses	0.046	2	0.092
T10	Destruction of pastures for greater output	0.044	2	0.088
T11	Lack of proper crop pattern	0.051	3	0.153
T12	Inadequate mechanisation policies/management	0.049	2	0.098
Total	—	1.000	—	2.37

Strategic Position and Strategy Formulation

Based on the combined results of the IFE and EFE matrices, the strategic position of agricultural mechanisation in East Azerbaijan Province was determined using the SWOT strategic framework (Figure 1). The calculated internal factor score was 2.53, which is above the benchmark value of 2.50, indicating that internal strengths slightly outweigh internal weaknesses. In contrast, the calculated external factor score was 2.37, which is below the benchmark value of 2.50, indicating that external threats outweigh available opportunities.

Accordingly, the mechanisation sector is positioned in the Strength–Threats (ST) quadrant of the SWOT matrix rather than the Weakness–Threats (WT) quadrant. This position implies that the province possesses relatively favourable internal capabilities, particularly local machinery production capacity (S10), spare-part availability (S11), and technical infrastructure (S12), but faces substantial external pressures such as water scarcity (T7), rising machinery prices (T2), climate-related risks (T1), and policy instability (T12). Therefore, the main strategic direction should focus on using existing internal strengths to mitigate, adapt to, or neutralise external threats.

Mathematically, if I represents the total weighted score of internal factors and E represents the total weighted score of external factors, the present study obtained I = 2.53 and E = 2.37. Since I > 2.50, the internal environment is relatively strong; since E < 2.50, the external environment is relatively threatening. Therefore, the strategic position corresponds to the ST quadrant. A WT position would only be justified if both internal and external scores were below the 2.50 threshold, i.e. I < 2.50 and E < 2.50.

On this basis, four categories of strategies were formulated: Strength–Opportunity (SO), Weakness–Opportunity (WO), Strength–Threats (ST), and Weakness–Threats (WT). However, given the final strategic position of the sector, ST-oriented strategies should be regarded as the primary strategic pathway. WO and WT strategies remain relevant as complementary operational measures, particularly for addressing financial constraints (W11), outdated machinery (W6), fragmented landholdings (W14), and repair-service limitations (W15).

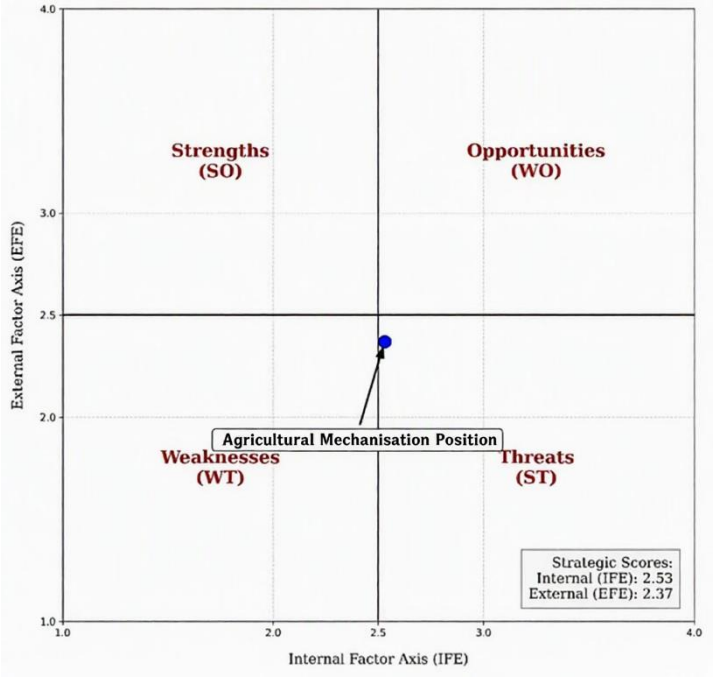


Fig. 1. The SWOT matrix coordinate axis

The strategic formulation process generated four categories of strategies: Strength–Opportunity (SO), Weakness–Opportunity (WO), Strength–Threats (ST), and Weakness–Threats (WT). A comprehensive list of these derived strategies, with specific examples and brief descriptions, is presented below in Table 4.

Table 4- Formulated Strategic Options (SO, ST, WO, and WT)

Strategy Category	Example Strategies (Codes)	Description
SO (Strengths-Opportunities)	Leverage local manufacturing (S10, S11) to seize export potential (O2).	Focus on enhancing domestic production capacity to meet international demand, particularly in neighbouring countries.
	Utilise expertise (S4) and research capacity (O6) to develop smart farming (O3).	
	Strengthen coordination (S6) with free trade zones (O1) for investment.	Integrate advanced mechanisation technologies by leveraging local expertise and research infrastructure. Enhance collaboration with economic zones to attract foreign direct investment in agricultural machinery.
ST (Strengths-Threats)	Use spare parts availability (S11) and local factories (S10) to counter machinery price increases (T2).	Prioritise domestic production and local supply chains to mitigate the impact of rising global machinery costs.
	Leverage mechanisation expertise (S4) and efficient machinery (S12) to address water scarcity (T1, T7).	Promote the adoption of water-efficient machinery and techniques that enhance operational efficiency despite water limitations.
	Strengthen coordination (S6) and rural workforce (S3) to manage climate change impacts (T1).	Develop adaptive mechanisation strategies that enhance resilience to climate variability and extreme weather events.

WO (Weaknesses-Opportunities)	Address farmer financial constraints (W11) by utilising farmer support funds (O9) and credit programs.	Develop targeted financial instruments and support schemes to enable smallholders to access modern machinery.
	Overcome fragmentation (W14) through rural cooperatives (O8) and farm consolidation initiatives.	Encourage the formation and strengthening of cooperatives to facilitate shared access to machinery and improve land-use efficiency.
	Improve technical knowledge (W1) by leveraging research capacity (O6) and knowledge-based companies (O4).	Enhance farmer training and extension services through partnerships with academic institutions and technology providers.
WT (Weaknesses-Threats)	Mitigate outdated machinery (W6) and repair limitations (W15) by focusing on essential maintenance and service support.	Prioritise the maintenance and repair of existing machinery to extend its lifespan and improve operational efficiency, especially in resource-limited areas.
	Address policy gaps (W12) by advocating for integrated mechanisation policies and management strategies.	Develop coherent national and regional policies that address mechanisation challenges and align with broader agricultural development goals.

Ranking of Criteria and Sub-Criteria Using the TOPSIS Method

To further prioritise the factors affecting agricultural mechanisation, the TOPSIS method was applied. The weights used in the TOPSIS analysis were derived from the SWOT evaluation results, ensuring consistency between the qualitative and quantitative stages of the study.

The ranking of the four main criteria is presented in Table 5. The results indicate that Strengths achieved the highest priority with a closeness coefficient (Pi) of 1.00, followed by Weaknesses (Pi = 0.827), Threats (Pi = 0.241), and Opportunities (Pi = 0.00). This finding suggests that internal strengths currently exert the greatest influence on the development of the mechanisation system in East Azerbaijan Province.

The high priority assigned to Strengths is consistent with the ST strategic position identified in the SWOT matrix. In other words, the province's internal strengths are not only important in themselves, but also represent the main strategic resources for responding to external threats.

Table 5- Criteria ranking

Rank	Pi	S_i^-	S_i^+	Weight	Criteria
1	1.000	0.29	0.00	0.39	Strengths
2	0.827	0.24	0.05	0.34	Weaknesses
3	0.241	0.07	0.22	0.17	Threats
4	0.000	0.00	0.29	0.10	Opportunities
		V_J^+: 0.39	V_J^-: 0.1		

A more detailed prioritisation of the sub-criteria within each strategic category is presented in Tables 6–9. These tables illustrate the relative importance of individual factors within the Strengths, Weaknesses, Opportunities, and Threats groups. After identifying the full set of internal and external factors through the SWOT framework, all factors were first evaluated during the screening and weighting stage. However, to ensure analytical focus and avoid redundancy in the TOPSIS procedure, only the highest-priority factors from each SWOT category were retained for detailed prioritisation. The

selection was based on the final importance weights obtained from the SWOT evaluation stage, and the top five factors in each category—Strengths, Weaknesses, Opportunities, and Threats—were entered into the TOPSIS analysis. Therefore, Tables 2 and 3 present the complete list of identified internal and external factors, whereas Tables 6–9 report only the subset of the most influential factors selected for the final ranking.

Table 6- TOPSIS weighted matrix for ranking strengths

Rank	Pi	S_i^-	S_i^+	Weight	Strengths
5	0.000	0.00	0.30	0.10	S_1
4	0.033	0.01	0.29	0.11	S_2
2	0.566	0.17	0.13	0.27	S_3
1	1.000	0.30	0.00	0.40	S_4
3	0.066	0.02	0.28	0.12	S_5
		V_J^+: 0.40	V_J^-: 0.10		

Table 7- TOPSIS weighted matrix for ranking weaknesses

Rank	Pi	S_i^-	S_i^+	Weight	Weaknesses
1	1.000	0.30	0.00	0.36	W_1
3	0.266	0.08	0.22	0.14	W_2
2	0.933	0.28	0.02	0.34	W_3
5	0.000	0.00	0.03	0.06	W_4
4	0.133	0.04	0.26	0.10	W_5
		V_J^+: 0.36	V_J^-: 0.06		

Table 8- TOPSIS weighted matrix for ranking opportunities

Rank	Pi	S_i^-	S_i^+	Weight	Opportunities
1	1.000	0.30	0.00	0.37	O_1
3	0.366	0.11	0.19	0.18	O_2
2	0.600	0.18	0.12	0.25	O_3
5	0.000	0.00	0.30	0.07	O_4
4	0.200	0.06	0.24	0.13	O_5
		V_J^+: 0.37	V_J^-: 0.07		

Table 9- TOPSIS weighted matrix for ranking threats

Rank	Pi	S_i^-	S_i^+	Weight	Threats
5	0.000	0.00	0.12	0.16	T_1
4	0.083	0.01	0.11	0.17	T_2
2	0.333	0.04	0.08	0.20	T_3
1	1.000	0.12	0.00	0.28	T_4
3	0.250	0.03	0.09	0.19	T_5
		V_J^+: 0.28	V_J^-: 0.16		

According to the TOPSIS methodology (Sarbazi, Sheikholeslami, & Omid, 2014), higher S_i- values indicate greater distance from the negative ideal solution, while lower S_i+ values reflect closer proximity to the positive ideal solution. The closeness coefficient (P_i) serves as the primary indicator for prioritisation, with values closer to one representing higher importance.

Overall, the results emphasise the dominant role of internal strengths in supporting agricultural mechanisation in East Azerbaijan Province. However, the simultaneous presence of significant weaknesses and external threats indicates that strategic planning should not rely solely on internal capacities. Instead, it should use these capacities as the basis for reducing vulnerability to external threats. In this context, the prioritisation results support the adoption of ST-oriented strategies as the main strategic direction, while WO and WT actions can be used as complementary mechanisms to address

structural weaknesses and operational constraints.

Discussion

The results of this study indicate that agricultural mechanisation development in East Azerbaijan Province is strongly influenced by internal structural conditions. The prioritisation of SWOT factors using the TOPSIS method demonstrated that internal strengths achieved the highest closeness coefficient, suggesting that existing institutional and industrial capacities play a central role in shaping the current mechanisation system. In particular, the presence of agricultural machinery manufacturing facilities (S10) and relatively good access to spare parts (S11) represent important structural advantages that can facilitate the expansion and sustainability of mechanisation in the region.

Despite these strengths, the analysis also revealed several significant internal weaknesses that constrain further progress. The most critical limitation identified was the widespread use of outdated and worn-out agricultural machinery (W6). This situation persists despite the presence of local manufacturing industries (S10) because, fundamentally, the replacement cycle for machinery is long, investment costs are high for individual farmers, and policy incentives for modernisation are insufficient. Furthermore, the fragmented structure of agricultural holdings (W14) makes it economically challenging for individual farmers to invest in new equipment, often leading to continued reliance on older, depreciated tools. This finding highlights the urgent need for structured machinery renewal programs, financial support mechanisms, and policies that encourage the gradual replacement of obsolete equipment with modern technologies.

External environmental conditions also play a substantial role in shaping mechanisation development. The results indicate that environmental and economic threats currently outweigh available opportunities in the province. Among these threats, the Urmia Lake environmental crisis (T8) and the rapid escalation of agricultural machinery prices (T2) were identified as the most critical external challenges. Water scarcity associated with the Urmia Lake crisis has significantly affected agricultural production systems in the region, thereby reducing farmers' capacity to invest in mechanisation. Similarly, inflation and rising equipment prices create substantial financial barriers for farmers seeking to modernise their machinery fleets.

The combination of a relatively favourable internal environment and an unfavourable external environment explains why the strategic position of the mechanisation sector falls within the ST quadrant. This means that the province should not adopt a purely defensive posture. Rather, it should actively mobilise its existing strengths, such as local machinery manufacturing, spare-part availability, mechanisation expertise, and institutional capacity to reduce exposure to external threats, including water scarcity, machinery price inflation, climate-related risks, and unstable policy conditions.

An apparent contradiction existed between the low priority assigned to Opportunities (Pi = 0.00) in Table 5 and the recommendation of WO strategies. This discrepancy is resolved by understanding that the prioritisation in Table 5 reflects the overall influence of the category of factors, while the selection of WO strategies is a strategic response to specific weaknesses that can be leveraged by available opportunities. Even if opportunities have a lower average weight, specific opportunities like "farmer support funds" (O9) can be crucial for overcoming weaknesses like "insufficient banking/credit access" (W11). Therefore, WO strategies remain relevant as complementary actions to address critical internal limitations, even when external opportunities are perceived as less dominant overall. The high ranking of T8 (Urmia Lake crisis) as a threat, while appearing to conflict with the ST position, reinforces it; the ST strategy emphasises using strengths to counter such significant threats.

The findings of this study are broadly consistent with previous research on agricultural mechanisation challenges. For

example, Moradi, Asakereh, and Sheikhdavoodi (2021) reported that internal strengths played a dominant role in mechanisation development in Ahvaz, reflected in a weighted internal factor score above 2.5. A similar pattern was observed in the present study, where the internal factor evaluation score also indicated the relative advantage of strengths over weaknesses. The findings of the present study also support previous research emphasising the multidimensional nature of agricultural mechanisation. Zangeneh, Omid, and Akram (2015) reported that mechanisation performance is influenced by a combination of machinery availability, energy utilisation, operational efficiency, and management-related factors. Similarly, the current SWOT analysis identified both internal and external factors as critical determinants of mechanisation development, indicating that strategic planning should address technical, economic, institutional, and infrastructural dimensions simultaneously. However, an important difference emerges regarding external conditions. While Moradi, Asakereh, and Sheikhdavoodi (2021) found that environmental opportunities outweighed threats in Ahvaz, the current study indicates the opposite situation in East Azerbaijan, where threats have greater influence than opportunities. This divergence likely reflects regional environmental conditions, particularly the severe ecological pressures associated with the Urmia Lake basin.

The present findings also correspond with the work of Ataei *et al.* (2021), who identified financial constraints and increasing machinery costs as major barriers to mechanisation adoption among farmers. Similarly, Jellali, Hachicha, and Aljuaid (2021) emphasised the role of environmental stress—especially water scarcity—in limiting agricultural productivity and mechanisation expansion. Furthermore, the results of the present study are consistent with previous investigations of agricultural mechanisation in Iran. Zangeneh and Banaeian (2014) reported that mechanisation development is influenced by a combination of technical, economic, and infrastructural factors, and that significant disparities may exist among production systems and regions. Similarly, the current study identified several internal and external constraints that limit mechanisation development in East Azerbaijan Province. In addition, Davarpanah, Hashemi Bonab, and Khodaverdizadeh (2016) highlighted structural challenges, such as outdated machinery, inefficient cropping patterns, and shortages of skilled labour. These issues were likewise reflected in the results of the current analysis, reinforcing the conclusion that technological modernisation must be accompanied by institutional and policy support.

An important contribution to this research lies in the integration of SWOT analysis with the TOPSIS multi-criteria decision-making method. While SWOT analysis provides a qualitative framework for identifying strategic factors, the application of TOPSIS allows for quantitative prioritisation of these factors based on expert judgment. This combined approach enhances analytical rigour and supports more structured strategic decision-making. By ranking both main criteria and sub-criteria, the study offers clearer guidance for policymakers regarding which factors require immediate attention and resource allocation. The effectiveness of prioritisation-based decision-support systems has been widely recognised in agricultural planning. Zangeneh, Akram, Nielsen, Keyhani, and Banaeian (2015) demonstrated that TOPSIS-based evaluation frameworks can significantly improve the selection of optimal alternatives in mechanisation-related planning problems. Consistent with their findings, the prioritisation results obtained in this study can assist policymakers in allocating resources more efficiently and focusing interventions on the most influential strengths, weaknesses, opportunities, and threats affecting mechanisation development in East Azerbaijan Province.

From a strategic perspective, the prioritisation results support the adoption of ST-oriented strategies as the primary pathway for improving agricultural mechanisation in East Azerbaijan Province. These strategies are

particularly relevant because they seek to use existing strengths, such as local machinery production, technical expertise, spare-part supply, and institutional coordination to mitigate external threats, such as rising machinery prices, water scarcity, climate stress, and unstable market conditions. At the same time, WO and WT measures remain important as complementary actions, especially for reducing internal weaknesses, such as outdated machinery, limited farmer credit access, fragmented landholdings, and inadequate repair-service infrastructure.

In practical terms, this means that mechanisation policy should not be limited to general recommendations for machinery expansion. Instead, it should prioritise targeted interventions, such as strengthening local machinery and spare-part production, expanding cooperative machinery-service centres, designing subsidised credit and leasing schemes for smallholders, upgrading repair and maintenance networks, and promoting water-efficient and conservation-oriented mechanisation technologies. Such measures can translate the ST strategic orientation into concrete operational actions while also addressing the weaknesses highlighted in the SWOT analysis.

The present findings are also consistent with the international literature showing that sustainable agricultural mechanisation is not merely a matter of equipment availability, but rather a strategic process shaped by institutional support, service provision, infrastructure, finance, and human capacity. FAO and related international studies emphasise that mechanisation should be developed within an enabling policy environment that supports productivity, sustainability, and inclusive access, particularly for smallholders and resource-constrained regions (FAO, 2021). From this perspective, the strengths identified in the current study, especially local manufacturing capacity and spare-part availability, reflect key system-level enablers that are widely recognised as critical for mechanisation sustainability.

Our results also align with the broader transition toward digital and smart farming. Recent international reviews have shown that agricultural digitalisation and automation can improve efficiency and resilience, but adoption remains constrained by high investment costs, limited connectivity, weak institutional support, and insufficient technical skills. This is especially relevant for regions where mechanisation systems are still developing, because the move toward smart mechanisation requires not only equipment modernisation but also coordinated investments in skills, extension, connectivity, and service models. In this regard, the weaknesses and threats identified in our study can be interpreted as structural barriers that may slow the transition from conventional mechanisation to more data-driven and adaptive farming systems.

In addition, the literature on agricultural robotics and automated equipment suggests that future mechanisation strategies should be oriented toward flexibility, service-based delivery, and integration with sustainability goals rather than simple machinery replacement. International policy frameworks likewise stress that mechanisation strategies must be context-specific and built around local agro-ecological, economic, and institutional conditions. The strategic priorities derived from this study therefore contribute to this global perspective by demonstrating that mechanisation development should be guided by a balanced assessment of internal capacities and external challenges.

Overall, the SWOT–TOPSIS prioritisation used in this study provides a structured decision-support approach that is compatible with international efforts to design evidence-based mechanisation policies. By identifying the most influential factors and translating them into strategic priorities, the present study offers a practical framework for strengthening agricultural mechanisation planning in a way that supports both competitiveness and sustainability.

Policy Implications and Operational Recommendations

To bridge the gap between strategic

formulation and practical execution, the strategic priorities identified in this study must be translated into concrete operational interventions. Since the final SWOT position corresponds to the ST quadrant, the main policy implication is that East Azerbaijan Province should use its internal strengths, particularly local machinery manufacturing (S10), spare-part availability (S11), technical expertise (S4), and institutional capacity (S6) to reduce vulnerability to external threats. However, because important internal weaknesses (W6, W11, W14, and W15) also remain, selected WO and WT actions are also necessary as complementary mechanisms.

These policy recommendations are consistent with the findings of Banaeian and Zangeneh (2011), who reported that improvements in mechanisation can enhance production efficiency and economic performance when supported by appropriate investment, management, and institutional frameworks. Therefore, strengthening mechanisation policies and support mechanisms may contribute substantially to the long-term sustainability and competitiveness of the agricultural sector in East Azerbaijan Province.

First, ST-oriented actions should focus on strengthening the province's capacity to withstand external environmental and economic pressures. The Agricultural Jihad Organization of East Azerbaijan Province, in collaboration with local machinery manufacturers, industrial clusters, and agricultural cooperatives, should support the expansion of domestic spare-part production and localised repair-service networks. This would reduce farmers' exposure to rising machinery prices (T2), import dependency, and supply-chain disruptions. In addition, local manufacturers in Tabriz and other industrial centres should be encouraged through tax incentives, low-interest operational loans, and innovation grants to produce high-demand implements, conservation tillage equipment, and water-efficient mechanisation technologies.

Second, WO-oriented actions should address capital constraints (W11) and smallholder fragmentation (W14) by using available opportunities, such as farmer support funds (O9), the Aras Free Trade Zone (O1), research centres (O5, O6), and knowledge-based companies (O4). Operationally, the Agricultural Jihad Organization, in partnership with Bank Keshavarzi, should establish a customised agricultural machinery leasing and credit program. Rather than providing generic loans, this program should prioritise cooperative-owned machinery pools and custom hiring centres. These centres would function as regional service hubs, allowing smallholder farmers to access modern machinery, conservation tillage equipment, smart planters, and precision input-application technologies without bearing the full cost of ownership.

Third, WT-oriented actions should focus on reducing vulnerabilities that may intensify under external threats. The provincial agricultural administration should collaborate with local technical universities, vocational schools, and extension centres to design mechanisation services and repair certification programs. These programs would address the shortage of skilled operators and technicians, reduce machinery downtime, and improve the efficiency of existing equipment. In regions affected by water scarcity (T1, T7) and the Urmia Lake crisis (T8), priority should be given to training programs and machinery services that support water-saving practices, conservation agriculture, and more efficient input use.

To facilitate implementation, the proposed recommendations can be organised into a three-tiered timeline. In the short term, over 1–2 years, policy efforts should focus on technical training programs, localised spare-part distribution networks, and upgrading existing repair workshops. In the medium term, over 3–5 years, the province should expand cooperative-run custom hiring centres and introduce subsidised leasing packages tailored for young farmers, agricultural graduates, and smallholders. In the long term, beyond 5 years, mechanisation policy should be linked with

land consolidation, crop-pattern optimisation, and the gradual integration of smart farming technologies such as sensor-based irrigation, precision fertiliser spreaders, and data-supported machinery services.

Finally, to ensure policy accountability, the progress of these interventions should be monitored through measurable key performance indicators. Proposed indicators include: (a) the density of machinery service centres per 1,000 hectares of cultivated land; (b) the average age of the tractor and machinery fleet in the province; (c) the utilisation rate of dedicated mechanisation credit and leasing programs; (d) the percentage of smallholders using custom hiring services; and (e) the number of certified machinery operators and repair technicians trained annually. These indicators would allow policymakers to move from broad strategic recommendations toward targeted, measurable, and evidence-based agricultural mechanisation planning.

Overall, the results emphasise that sustainable mechanisation development in East Azerbaijan Province requires an ST-led strategic approach supported by complementary WO and WT operational measures. The province has important internal strengths, particularly in local machinery production, spare-part availability, and technical capacity, but these strengths must be actively mobilised to respond to external threats, such as water scarcity, rising machinery prices, climate-related risks, and policy instability. Effective policymaking, institutional coordination, targeted investment in modern and water-efficient machinery, and measurable implementation mechanisms will therefore play a critical role in ensuring the long-term resilience and productivity of the province's agricultural sector.

Conclusion

This study aimed to identify and prioritise the key factors influencing agricultural mechanisation development in East Azerbaijan Province using an integrated SWOT–TOPSIS approach. The SWOT framework was employed to systematically identify internal strengths and weaknesses as well as external opportunities and threats, while the TOPSIS method enabled the quantitative prioritisation of these factors based on expert evaluations.

The results of the internal and external factor evaluations indicated that internal strengths slightly outweigh weaknesses, whereas external threats exert a stronger influence than available opportunities. This strategic position suggests that although the province benefits from important structural advantages, such as the presence of agricultural machinery manufacturing facilities (S10) and relatively good access to spare parts (S11) significant challenges remain that may hinder future mechanisation progress.

The ANP-based prioritisation of factors revealed that among the main criteria, Strengths hold the highest influence (Weight = 0.39), followed by Weaknesses (Weight = 0.34), Threats (Weight = 0.17), and Opportunities (Weight = 0.10). Among the individual factors, the competence of mechanisation experts (S4), availability of spare parts (S11), and local machinery factories (S10) emerged as highly influential strengths. The most critical weakness identified was the widespread use of outdated and worn-out machinery (W6). Regarding external factors, the Urmia Lake environmental crisis (T8) and increased machinery prices (T2) were recognised as the most serious threats, while opportunities such as attracting foreign investment (O1) and export potential (O2) present avenues for growth.

Based on the overall strategic analysis, the results indicate that the agricultural mechanisation sector in East Azerbaijan Province is positioned in the Strengths–Threats (ST) quadrant of the SWOT matrix. This means that the province's relatively strong internal capacities should be used strategically to mitigate, adapt to, and manage external threats. Therefore, ST-oriented strategies should be regarded as the primary strategic direction for sustainable mechanisation development, while WO and WT strategies may serve as complementary operational measures for addressing persistent internal weaknesses and implementation constraints.

The prioritised strategies, based on the TOPSIS analysis of the derived SWOT strategy categories, indicate the following order of importance:

1. ST strategies (highest priority)**:** leveraging internal strengths (e.g. local manufacturing, spare parts availability) to counter external threats (e.g. rising prices, environmental crises).
2. WO strategies**:** addressing internal weaknesses (e.g. limited credit access, outdated machinery) by utilising available opportunities (e.g. farmer support funds, technological advancements).
3. ST strategies (specific actions)**:** utilising expertise and coordination to manage climate impacts and water scarcity.
4. WT strategies**:** mitigating vulnerabilities by improving policy and management, particularly in response to environmental and economic pressures.

From a policy perspective, several practical implications emerge:

- Targeted financial support, leasing, and credit facilities are needed for machinery renewal, addressing weaknesses like W6 and W11 by leveraging opportunities like O9.
- Strengthening domestic machinery manufacturing, local repair networks, and spare-part access (S10, S11) can mitigate external shocks like T2 and T8, aligning with ST strategies.
- Policies attracting investment and supporting knowledge-based firms (O1, O4) can foster growth, linking strengths (S4, S6) with opportunities.
- Integrated resource management, particularly concerning water scarcity and ecological pressures (T1, T7, and T8), should be central to future planning, using ST strategies to build resilience.

The findings suggest that sustainable mechanisation involves more than just equipment acquisition; it requires a holistic approach encompassing finance, technical services, local capacity, training, and adaptive policy support. The integrated SWOT–ANP–TOPSIS framework proved effective for strategic assessment and prioritisation.

Future research on agricultural mechanisation should focus on hybrid decision-making models to handle uncertainty, comparative provincial analyses for tailored policies, climate change scenarios for adaptive planning, economic return assessments, and socio-economic factors affecting the adoption of advanced technologies like precision agriculture and robotics.

In conclusion, this study provides a structured evidence-based basis for policymakers and agricultural planners to design targeted strategies that enhance the efficiency, sustainability, and resilience of mechanisation systems in East Azerbaijan Province. By combining strategic diagnosis with quantitative prioritisation, the study contributes to both a methodological approach and a practical decision-support framework for regional mechanisation planning under conditions of environmental and economic uncertainty.

Conflict of Interest: The authors declare no conflict of interest.

Author Contributions

S. M. Mousavi: Methodology, Data acquisition, Data pre- and post-processing, Visualisation, and Software services. Conducted the research procedures, collected and processed the primary data, performed data analysis and visualization, and contributed to drafting the initial manuscript.

A. Taheri Hajivand: Supervision, Conceptualisation, Methodology, Technical advice, Validation, and Review and editing services. Conceived the research concept, guided the methodology, supervised the entire investigation, validated the strategic modelling and results, and critically reviewed and revised the manuscript.

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ارزیابی راهبردی و اولویت‌بندی توسعه مکانیزاسیون کشاورزی در استان آذربایجان شرقی ایران با استفاده از رویکرد تلفیقی SWOT–TOPSIS

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چکیده

توسعه پایدار کشاورزی در ایران به‌طور فزاینده‌ای به استراتژی‌های مکانیزاسیونِ بومی‌سازی‌شده‌ای وابسته است که ظرفیت‌ها و محدودیت‌های منطقه‌ای را لحاظ کنند. این مطالعه با هدف شناسایی و اولویت‌بندی مسیرهای راهبردی برای توسعه مکانیزاسیون کشاورزی در استان آذربایجان شرقی با استفاده از چارچوب یکپارچه SWOT-TOPSIS انجام شد. پژوهش حاضر از نوع توصیفی–تحلیلی و با رویکرد آمیخته (کیفی–کمی) اجرا شد؛ به‌گونه‌ای که ابتدا عوامل درونی و بیرونی مؤثر بر مکانیزاسیون، با بهره‌گیری از نظرات خبرگان و تحلیل SWOT شناسایی و دسته‌بندی شدند. جامعه آماری شامل متخصصان، شرکت‌ها و تعاونی‌های مکانیزاسیون و کارشناسان سازمان جهاد کشاورزی استان آذربایجان شرقی بود. با توجه به ضرورت دسترسی به قضاوت‌های تخصصی، از روش نمونه‌گیری هدفمندِ قضاوت‌محور (غیرتصادفی) استفاده شد و شرکت‌کنندگان بر اساس تخصص مرتبط، تجربه عملی و آشنایی با مسائل مکانیزاسیون در استان انتخاب شدند. داده‌ها از طریق پرسشنامه‌ای ساختاریافته از ۱۰۲ نفر از کارشناسان مکانیزاسیون کشاورزی جمع‌آوری گردید. سپس برای اولویت‌بندی عوامل شناسایی‌شده، از تکنیک اولویت‌بندی بر اساس شباهت به راه‌حل ایده‌آل (TOPSIS) استفاده شد. نتایج نشان می‌دهد که نقاط قوت درونی در حال حاضر بستر نسبتاً مناسبی را برای توسعه مکانیزاسیون فراهم کرده‌اند (امتیاز وزنی عوامل درونی = ۲/۵۳) که عمدتاً ناشی از وجود صنایع ماشین‌آلات کشاورزی و دسترسی به قطعات یدکی است؛ با این حال، تهدیدهای بیرونی بر فرصت‌های موجود غلبه دارند (امتیاز وزنی عوامل بیرونی = ۲/۳۷) و بحران زیست‌محیطی دریاچه ارومیه و افزایش قیمت ماشین‌آلات به‌عنوان بحرانی‌ترین محدودیت‌ها شناخته شدند. در میان عوامل درونی و بر اساس وزن‌های به‌دست‌آمده، ظرفیت تولید محلی و دسترسی به قطعات یدکی به‌عنوان تأثیرگذارترین نقاط قوت، و فرسودگی ماشین‌آلات و خرد بودن ساختار مزارع به‌عنوان مهم‌ترین نقاط ضعف ارزیابی شدند. بر اساس جایگاه راهبردی SWOT، بخش مکانیزاسیون کشاورزی استان آذربایجان شرقی در ربع قوت‌ها–تهدیدها (ST) قرار گرفت؛ بنابراین، مناسب‌ترین راهبردها آن‌هایی هستند که از نقاط قوت درونی برای کاهش یا جبران تهدیدهای بیرونی استفاده کنند. بر همین اساس، اولویت‌بندی راهبردها باید معطوف به بهره‌گیری از توانمندی‌های داخلی جهت کاهش فشارهای بیرونی، به‌ویژه تقویت ظرفیت ساخت داخل، بهبود خدمات تعمیر و نگهداری و ارتقای تاب‌آوری در برابر فشارهای زیست‌محیطی و بازاری باشد. چارچوب تحلیلی پیشنهادی، بینش‌های مبتنی بر شواهدی را ارائه می‌دهد که برای سیاست‌گذاران و برنامه‌ریزان بخش کشاورزی حیاتی بوده و از طراحی سیاست‌های مؤثرتر و منطقه‌محور در راستای توسعه پایدار کشاورزی در استان آذربایجان شرقی پشتیبانی می‌کند.

واژه‌های کلیدی: استان آذربایجان شرقی، ایران، برنامه‌ریزی راهبردی، تلفیق SWOT-TOPSIS، توسعه مکانیزاسیون، مکانیزاسیون کشاورزی

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