

## MATRIX METHODOLOGIES FOR ENHANCING ECONOMIC EFFICIENCY IN UZBEKISTAN'S TEXTILE SECTOR: INSIGHTS FROM POLICY AND OPTIMIZATION FRAMEWORKS

Authors: Assistant of the Department of “Automation and Software Engineering”:

**Sh.Madirimov**

Student of the Department of “Automation and Software Engineering”:

**A.Akilov**

Tashkent Institute of Textile and Light Industry

**Abstract:** Uzbekistan's textile industry, a vital pillar of its economy, grapples with challenges in resource allocation, competitiveness, and sustainability within a transitioning post-Soviet landscape. This article explores the application of matrix-based methodologies in economic modeling for the textile sector, utilizing the Policy Analysis Matrix (PAM) to evaluate comparative advantages and matrix decision-making algorithms to optimize economic potential. Leveraging empirical data from Uzbekistan's cotton production and textile clusters, the study uncovers inefficiencies stemming from historical policy distortions, water scarcity, and market constraints, while proposing strategic scenarios for improvement. Key findings encompass domestic resource cost (DRC) indicators revealing comparative advantages in efficient cotton variants and aggregated efficiency indices identifying clusters for diversification. The fusion of these matrices promotes allocative efficiency, sustainable development, and targeted policy reforms, enriching the discourse on industrial economics in emerging markets.

**Keywords:** Policy Analysis Matrix, Economic Potential Optimization, Uzbekistan Textile Competitiveness, Comparative Advantage, Decision-Making Matrices, Resource Allocation Efficiency, Sustainability in Cotton Production

### Introduction

In the modern economic context, Uzbekistan's textile industry represents an intricate nexus of resource management, policy frameworks, and market forces. Matrix methodologies, as outlined in economic modeling scholarship, offer a sturdy apparatus for unraveling these interconnections. These techniques, including linear algebraic formulations and intersectoral matrices, enable the systematic breakdown of issues into organized elements, facilitating optimal decision-making [6]. In Uzbekistan's textile domain, matrices prove essential for assessing efficiency, projecting scenarios, and alleviating distortions from state interventions, water shortages, and export dependencies.

The Policy Analysis Matrix (PAM), originated by Monke and Pearson (1989) [4], measures private and social profitability to determine comparative advantages. Likewise, matrix algorithms for economic potential optimization amalgamate resource and institutional elements, producing aggregated indices for strategic alignment [5]. This article amalgamates insights from these instruments, tailored to Uzbekistan's textile milieu, to emphasize their applicability. Incorporating sustainability facets from next-generation textiles (NGTs), it propounds a comprehensive viewpoint on economic optimization [2]. Uzbekistan, a top cotton producer with output at 621,000 metric tons in 2023/24 and textile exports targeting \$3.3 billion by 2026, stands to benefit from these approaches amid reforms shifting from raw cotton to value-added processing [7, 8].

### Methodology

**Policy Analysis Matrix (PAM) Approach**

The PAM structure assembles a matrix of revenues, costs, and profits at private and social tiers, as depicted in Table 1. Private valuations mirror market prices, whereas social valuations integrate opportunity costs, rectified for policy transfers. Pivotal metrics include:

1. **Nominal Protection Coefficient (NPC):**  
Proportion of domestic to international prices.
2. **Effective Protection Coefficient (EPC):**  
Quotient of value added at private to social prices.
3. **Domestic Resource Cost (DRC):** Shadow valuation of non-tradable inputs per tradable value added unit, where  $DRC < 1$  signifies comparative advantage.

Mathematically, the PAM is denoted as:

$$\begin{bmatrix} A & B & C & N \\ D & E & F & O \\ G & H & I & P \end{bmatrix}$$

Where:

$$N = A - B - C \text{ (Private Profit)}$$

$$O = D - E - F \text{ (Social Profit)}$$

$$P = G - H - I \text{ (Net Policy Transfer)}$$

The DRC is computed as:  $DRC = \frac{F}{D-E}$

The EPC is expressed by:  $EPC = \frac{A-B}{D-E}$

And NPC for output (NPCO) and inputs (NPCI) are:  $NPCO = \frac{A}{D}$ ,  $NPCI = \frac{B}{E}$

This approach was employed in Uzbekistan’s cotton sector across key regions, utilizing data on yields, inputs, and global benchmarks [1].

**Table 1: Basic Structure of the Policy Analysis Matrix (PAM)**

	Value of Output	Value of Input (Tradable)	Domestic Factor	Profit
<b>Private Prices</b>	A	B	C	$N = A - (B + C)$
<b>Social Prices</b>	D	E	F	$O = D - (E + F)$
<b>Policy Transfer</b>	$G = A - D$	$H = B - E$	$I = C - F$	$P = N - O$

Source: Adapted from [1]

**Matrix Decision-Making Algorithm for Economic Potential**

This algorithm dissects economic potential (EP) into resource (productive) and institutional (factor) constituents, constructing state matrices for profitability, return, and intensity. Indicative dynamics matrices consolidate sub-indices (I<sub>rp</sub>: resource potential; I<sub>ip</sub>: institutional potential; I<sub>ep</sub>: integral EP) via multi-level normalization. Point positioning in strategic matrices discerns clusters and optimization scenarios [5].

The sub-indices aggregation adheres to a hierarchical framework. At the primary level, local potentials are normalized:

$$I_{rpi} = \frac{\sum_{j=1}^n w_j \cdot X_{ij}}{\sum_{j=1}^n w_j \cdot X_{j_{max}}}$$

Where  $x_{ij}$  denotes the indicator value for element  $j$  in potential  $i$ , and  $w_j$  are weights. Secondary aggregation merges these into resource and institutional sub-indices:

$$I_{rp} = \prod_{i=1}^m I_{rp_i}^{a_i}, \quad I_{ip} = \prod_{i=1}^m I_{ip_i}^{b_i}$$

The integral EP index is:

$$I_{ep} = \sqrt[3]{I_{rp} \cdot I_{ip} \cdot I_{pi}}$$

Where  $I_{pi}$  is the potential intensity sub-index. Implementation targeted Uzbekistan's textile clusters, such as those in Tashkent and Samarkand [3].

## Results

### Comparative Advantage in Uzbekistan Cotton Production

Employing PAM, Bobojonov and Franz (2003) [1] disclosed notable inefficiencies. In Bukhara, a primary cotton region, DRC for traditional cotton reached 0.88, approaching the threshold and signaling marginal advantage compared to wheat (DRC=0.54) amid diversification policies. Protection coefficients (Table 2) exhibit EPC variances by region, with Fergana and Andijan benefiting from incentives (EPC > 1), whereas Khorezm encounters net taxation (EPC < 1) due to salinity and water issues.

**Table 2: Protection Coefficients for Cotton in Major Uzbek Regions (Adapted Data)**

Region & Protection Coefficient	NPCO (Cotton)	NPCI (Cotton)	EPC (Cotton)
<b>Fergana</b>	1.05	0.85	1.12
<b>Andijan</b>	0.95	0.90	1.02
<b>Bukhara</b>	1.02	0.82	1.08
<b>Khorezm</b>	0.70	0.88	0.65
<b>Jizzakh</b>	0.65	0.87	0.58

Source: Adapted from [1, 7]

Rankings (Table 3) affirm cotton's variable standing, requiring yield enhancements up to 150% for sustained competitiveness, especially shifting to efficient variants like cotton under plastic.

**Table 3: Ranking of Comparative Advantage by Crop in Each Region**

Region	Crop Ranking by DRC (1 = Highest Advantage)
<b>Fergana</b>	Cotton (1), Wheat (2), Rice (3)
<b>Andijan</b>	Wheat (1), Fruits (2), Cotton (3)
<b>Bukhara</b>	Wheat (1), Cotton (2), Vegetables (3)
<b>Khorezm</b>	Rice (1), Cotton (2), Wheat (3)
<b>Jizzakh</b>	Fruits (1), Wheat (2), Cotton (3)

Source: Adapted from [1]

### Optimization in Uzbekistan Textile Clusters

Khasanov et al.'s (2025) [3] matrix algorithm produced aggregated indices for Uzbek textile clusters. The Tashkent cluster attained the highest integral EP index (1.005), whereas Bukhara lagged at 0.920 (Table 4). Dynamics scrutiny (Table 5) indicated average annual profitability

declines (0.870 for resource; 0.860 for institutional), stressing the imperative for pricing reforms and green investments.

**Table 4: Aggregated Indices of Economic Potential for Uzbek Textile Clusters**

Cluster	Resource Subindex	Potential	Institutional Subindex	Capacity	Integral EP Index
<b>Tashkent</b>	0.955		0.980		0.967
<b>Samarkand</b>	0.990		0.998		0.994
<b>Fergana</b>	0.982		0.956		0.969
<b>Andijan</b>	0.965		0.950		0.957
<b>Bukhara</b>	0.918		0.920		0.919
<b>Khorezm</b>	1.015		0.992		1.003
<b>Jizzakh</b>	0.920		0.922		0.921

Source: Adapted from [3]

**Table 5: Average Annual Performance Indicators for Potential Efficiency in Textile Clusters**

Dynamics Comparison	Resource Potential Output	Resource Potential Intensity	Resource Profitability	Institutional Output	Institutional Intensity	Institutional Profitability
<b>2021/2020</b>	1.235	1.232	0.655	1.112	1.075	0.605
<b>2022/2021</b>	0.920	1.030	0.608	0.975	1.100	0.635
<b>2023/2022</b>	0.980	0.932	0.315	0.830	0.772	0.272
<b>2024/2023</b>	1.045	1.032	2.970	1.255	1.278	3.495
<b>2025/2024</b>	1.115	1.168	1.338	1.068	1.100	1.292
<b>Average Annual Index</b>	1.055	1.075	0.870	1.040	1.052	0.860

Source: Adapted from [3]

Strategic positioning clustered entities into quadrants, advocating centered diversification (SD-1) for clusters like Tashkent, prioritizing innovation and sustainability certifications.

**Discussion**

Matrix methodologies surpass static evaluations, delivering dynamic perspectives on Uzbekistan’s textile economics. PAM underscores policy-induced inefficiencies, resonating with diversification strategies favoring wheat in saline regions like Bukhara [1]. In textile clusters, the algorithm pinpoints imbalances, endorsing public-private partnerships for sustainable EP augmentation [3]. Merging intersectoral input-output matrices [6] could model supply chains further, while NGT progressions [2] advocate matrices for lifecycle appraisals, advancing eco-efficiency.

Globally, these instruments address hurdles like water scarcity and forced labor legacies, cultivating resilience in fluctuating markets.

**Conclusion**

Matrix-oriented methodologies are crucial for refining economic results in Uzbekistan’s textile industry, permitting exact efficiency appraisals and strategic prescience. Empirical outcomes

highlight the necessity for policy overhauls and innovation-led scenarios to bolster competitiveness and sustainability. Prospective inquiries should broaden these matrices to encompass machine learning for prognostic analytics, guaranteeing the sector's adaptability in a globalized economy.

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