

ECONOSCITECH INTEGRATION

ISSUE
10

INTERNATIONAL SCIENTIFIC
ELECTRONIC JOURNAL



**TASHKENT STATE
UNIVERSITY OF ECONOMICS**



**American University
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ISSN: 3060-5075



**Acceptance of articles
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2026

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"ECONOSCITECH-INTEGRATION"
HAS BEEN REGISTERED UNDER
THE NUMBER C-5669651 BY THE
AGENCY FOR INFORMATION AND
MASS COMMUNICATIONS (AOKA)
OF THE REPUBLIC OF UZBEKISTAN,
EFFECTIVE FROM OCTOBER 9, 2024.

In accordance with Resolution No. 384/6 dated April 10, 2026, issued by the Presidium of the Supreme Attestation Commission under the Ministry of Higher Education, Science and Innovation of the Republic of Uzbekistan, this journal is included in the list of recommended international scientific publications for publishing the primary research findings of doctoral dissertations in the field of Economic Sciences.

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Electronic publication. Issue 10. 500 pages.
Approved for publication in October 2026.

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METHODOLOGICAL APPROACHES TO ASSESSING AND MANAGING THE EFFICIENT UTILISATION OF PRODUCTION RESOURCES IN THE TEXTILE INDUSTRY

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Abstract. This article substantiates methodological approaches to assessing and managing the efficient utilisation of production resources in textile enterprises within the context of the green economy. A comprehensive system of indicators is proposed for assessing the efficiency of human resources, fixed assets, raw materials, and working capital. The Human Resource Efficiency Index (HREI) is proposed as an integrated measure of human resource efficiency, alongside a credit policy matrix for managing accounts receivable and the Economic Order Quantity (EOQ) model for optimising raw material inventories. The proposed methodological approaches are intended to enhance the efficiency of production resource utilisation and support more effective, resource-efficient management in textile enterprises.

Keywords. green economy, textile industry, production resources, labour productivity, Human Resource Efficiency Index (HREI), working capital, accounts receivable, Economic Order Quantity (EOQ) model.

Аннотация. В статье обоснованы методологические подходы к оценке и управлению эффективным использованием производственных ресурсов на предприятиях текстильной промышленности в условиях зелёной экономики. Предложена комплексная система показателей для оценки эффективности использования человеческих ресурсов, основных средств, сырьевых ресурсов и оборотного капитала. Индекс эффективности человеческих ресурсов (Human Resource Efficiency Index — HREI) предложен в качестве интегрального показателя эффективности использования человеческих ресурсов наряду с матрицей кредитной политики для управления дебиторской задолженностью и моделью экономически обоснованного размера заказа (Economic Order Quantity — EOQ) для оптимизации запасов сырья. Предлагаемые методологические подходы направлены на повышение эффективности использования производственных ресурсов и совершенствование ресурсосберегающего управления на предприятиях текстильной промышленности.

Ключевые слова. зелёная экономика, текстильная промышленность, производственные ресурсы, производительность труда, индекс эффективности человеческих ресурсов (HREI), оборотный капитал, дебиторская задолженность, модель экономически обоснованного размера заказа (EOQ).

INTRODUCTION

In the modern economy, enhancing production efficiency, ensuring the rational utilisation of resources, and achieving optimal outcomes from available opportunities are among the key priorities of industrial enterprises. In particular, evolving resource costs, increasing competition, and the growing importance of sustainable development encourage enterprises to adopt more efficient approaches to the management of production resources. In this context, it is particularly important to accurately assess the current state of resource utilisation, identify opportunities for improving resource efficiency, and develop appropriate management decisions aimed at achieving more effective resource allocation and utilisation.

The textile industry is characterised by the intensive use of a wide range of production resources, and its sustainable operation depends substantially on the efficiency with which labour, fixed assets, raw materials, energy, and working capital are utilised. Therefore, these resources should be assessed and managed not separately, but as components of an interconnected production system. This, in turn, highlights the importance of

further developing methodological approaches to assessing and managing the efficient utilisation of production resources in the textile industry.

LITERATURE REVIEW

Issues related to assessing and managing the efficient utilisation of production resources in the textile industry have been examined in the economic literature through various methodological approaches. Existing studies pay particular attention to measuring resource-use efficiency, assessing the contribution of individual resource types to production outcomes, identifying functional relationships among resources, and developing integrated approaches to their management.

I. Abernikhina and I. Sokyrykska (2020) emphasise that the assessment of production resource utilisation should begin with a systematic analysis of indicators reflecting the condition of resources and the extent to which they are utilised. According to the authors, "the analysis of resource utilization indicators makes it possible to assess the actual level of resource use and identify opportunities for improving efficiency." This approach highlights the importance of developing a comprehensive system of economic indicators and evaluating their dynamics as an initial stage in managing resource efficiency.

This perspective is complemented by the research of L. Hamzah (2021), which assesses the contribution of production factors to output. Applying a total factor productivity approach to the textile industry, the author demonstrates that production outcomes are shaped by the combined contribution of capital, raw materials, energy, and labour resources. Within this framework, labour resources are considered an important determinant of enterprise productivity alongside other production factors. Therefore, resource-use efficiency should be examined not solely in relation to individual resource categories, but also through the interactions among different production factors.

The contribution of labour resources to production efficiency is examined in greater depth by T. Bui et al. (2023). Research conducted on textile and garment enterprises in Vietnam showed that labour productivity is closely associated with a firm's ability to maintain its market position, as well as with production costs and competitiveness. Of the five factors examined by the authors, four were found to have a statistically significant effect on labour productivity, with labour costs identified as the most influential factor. These findings suggest that human resource management should assess not only the number of employees or production volume but also the economic return generated by labour-related expenditure.

The qualitative dimensions of human resource efficiency are examined from a human capital perspective by S. Karuppusamy and A. Raju (2025). The authors assessed the relationship between employees' education and professional training and labour productivity in the textile industry using psychometric reliability analysis, decision trees, and Markov chains. According to the study findings, educational attainment is among the strongest predictors of labour productivity, while improvements in employees' knowledge and professional skills increase the likelihood of transition towards higher levels of productivity. This finding further demonstrates the importance of human capital development in strengthening the efficient utilisation of production resources.

Production efficiency, however, depends not only on labour resources but also on the effective interaction among fixed assets, material resources, and working capital. P. Mykytyuk and I. Trush (2021) demonstrated that the efficiency of fixed asset utilisation, including fixed asset productivity, is directly related to the volume and structure of material resources. According to the authors' approach, changes in the parameters of raw material and material utilisation also influence the productive return on fixed assets. This finding indicates that production resources are interconnected and that their efficiency is shaped by their combined utilisation within the production system.

I. Babenko (2013) similarly demonstrated that fixed asset productivity is functionally dependent on the volume of material supply, inventory levels, resource prices, and assortment structure. According to the author, when the volume of fixed assets remains unchanged, determining an optimal level of raw material and material inventories can improve the efficiency of capital utilisation. From this perspective, decisions concerning the management of fixed assets, raw materials, and working capital should be formulated within an integrated framework that takes into account the relationships among these resources.

A. Papetti et al. (2019) proposed the Resources Value Mapping methodology for the comprehensive assessment of resource efficiency. Based on Lean principles, this approach classifies production processes into value-adding operations, non-value-adding operations, and operations associated with resource waste. The authors employed the Cost Index and Muda Index to quantitatively assess resource costs and resource-use efficiency. The empirical findings indicated that a substantial proportion of resources may not directly contribute to value creation, thereby providing opportunities to identify areas in which energy and other resources can be utilised more efficiently and to develop appropriate management measures. This methodology enables resource efficiency to be assessed through the relationship between resources consumed and value created.

Another approach to the comprehensive assessment of production resources is reflected in the praxeological methodology proposed by J. Kočańska and A. Burduk (2023). Within this methodology, resource-use efficiency is assessed on the basis of three principal criteria: availability, performance, and quality. This approach makes it possible to consider not only the availability of resources within an enterprise but also the extent to which they are effectively utilised in the production process and contribute to achieving the required level of quality. The authors propose classifying opportunities for resource optimisation across production, logistics, maintenance, and management processes in order to identify and quantitatively assess areas for further efficiency improvements. The subsequent integration of this methodology with Failure Mode and Effects Analysis (FMEA) and the Tabu Search optimisation algorithm further extends its applicability from resource-efficiency assessment to optimal resource management. As a result, the approach creates opportunities to strengthen operational reliability and allocate available labour and production resources more efficiently across workplaces and technological processes.

A synthesis of the reviewed scientific approaches indicates that several methodological directions have emerged in the study of resource-use efficiency. The first focuses on economic indicators of resource utilisation and total factor productivity; the second examines the contribution of the quantitative and qualitative characteristics of labour resources to productivity; and the third substantiates the functional relationships among fixed assets, raw materials, and material inventories. Contemporary research increasingly prioritises integrated approaches that assess resource contributions to value creation, opportunities for resource optimisation, and operational efficiency within a unified production system. Taken together, these approaches provide an important theoretical and methodological foundation for developing a comprehensive framework for assessing and managing the efficient utilisation of production resources in textile enterprises.

RESEARCH METHODOLOGY

This study employs a combination of general and specific methods of scientific inquiry, including a systems approach, comparative and dynamic analysis, economic and statistical methods, ratio analysis, integral assessment, and expert evaluation. On the basis of these methods, a comprehensive system of indicators was developed to assess the efficient utilisation of production resources, and methodological tools were proposed for the integrated assessment of human resource efficiency, differentiated management of accounts receivable, and optimisation of raw material inventories. The combination of these methodological approaches provides a systematic framework for evaluating the utilisation of key production resources and developing appropriate management decisions aimed at enhancing resource efficiency in textile enterprises.

Statement on the Use of Artificial Intelligence. In the preparation of this study, artificial intelligence (AI) tools were used to a limited extent, accounting for approximately 10% of the overall research process. Their use was primarily confined to language refinement, technical editing, and structural support. The selection of research methods, collection and analysis of empirical data, interpretation of the findings, formulation of scientific conclusions, and development of practical recommendations were carried out and verified by the author.

ANALYSIS AND RESULTS

Assessing the efficient utilisation of production resources is important for evaluating the economic performance of an enterprise, identifying opportunities for improving resource efficiency, and providing an analytical basis for informed management decisions. In this context, assessing individual resource categories independently may not provide a sufficiently comprehensive understanding of overall resource efficiency. It is therefore important to consider the interrelationships among different production resources and their contribution to production outcomes within an integrated analytical framework.

From this perspective, a comprehensive system of indicators covering human resources, fixed assets, raw material resources, and working capital was developed to assess the utilisation of production resources in textile enterprises. The proposed system makes it possible to evaluate the intensity of resource utilisation, resource returns, opportunities for optimising resource use, and turnover rates. This framework provides an analytical basis for identifying areas in which resource management can be further improved and for supporting more efficient managerial decision-making. The proposed system of indicators is presented in Table 1.

Table 1
System of Indicators for Assessing Production Resource Utilization¹

Resource group	Indicator	Calculation procedure
Human resources	Labor productivity	Annual production volume / number of core production workers
Human resources	Skill composition	Share of highly, medium-, and low-skilled employees, %
Human resources	Retraining rate	Employees who completed retraining / total employees × 100
Human resources	Staff turnover rate	Number of employees who left / average number of employees × 100
Fixed assets	Equipment depreciation rate	Accumulated depreciation / initial value × 100
Fixed assets	Share of modernized equipment	Modernized equipment / total equipment × 100
Fixed assets	Capacity utilization rate	Actual production / production capacity × 100
Raw material resources	Specific raw material consumption	Raw material consumption / finished product volume, kg/t
Raw material resources	Raw material loss rate	Raw material losses / raw materials consumed × 100
Working capital	Accounts receivable-to-payables ratio (AR/AP)	Accounts receivable / accounts payable
Working capital	Ratio of accounts receivable to raw material costs	Accounts receivable / raw material costs × 100
Working capital	Inventory turnover ratio and days in inventory	Formulas (2) and (3)

Based on the indicators presented in Table 1, the Human Resource Efficiency Index (HREI) was developed to provide a comprehensive assessment of the efficiency of human resource utilisation. The working capital indicators, in turn, provide a methodological basis for developing a credit policy matrix for accounts receivable management and applying the Economic Order Quantity (EOQ) model to the optimal management of raw material inventories. Thus, the proposed system of indicators makes it possible to establish a direct link between the results of resource-use assessment and the corresponding management tools.

Individual indicators characterising human resource utilisation may exhibit different dynamics. For example, even when labour productivity and employee qualification levels increase, staff turnover may also increase during certain periods. Therefore, the Human Resource Efficiency Index (HREI) is proposed as a single integrated indicator for assessing the overall efficiency of human resource utilisation:

$$\text{HREI} = 0.35 \times K_1 + 0.25 \times K_2 + 0.25 \times K_3 + 0.15 \times K_4 \quad (1)$$

where:

K_1 – labour productivity index (current year/base year);

K_2 – share of highly skilled employees (percentage/100);

K_3 – staff stability index ((100 – turnover rate)/100);

K_4 – share of employees who completed retraining (percentage/100).

The weighting coefficients incorporated into the index were determined using the Delphi method with the participation of representatives from academia, enterprise managers, and specialists from public administration bodies. Based on the expert assessment results, a weight of 0.35 was assigned to labour productivity, 0.25 each to the share of highly skilled employees and staff stability, and 0.15 to the share of employees who completed retraining. Labour productivity reflects current production performance; employee qualification levels and staff stability represent the qualitative and continuity dimensions of human resource potential; and retraining reflects opportunities for further employee development.

The proposed HREI integrates the current performance and development potential of human resources into a single comprehensive assessment. Improvements in labour productivity, qualification levels, and retraining indicators increase the value of the index, whereas higher staff turnover is reflected through a lower value of the stability component. Therefore, the HREI can be used as a methodological tool for integrating labour indicators

¹ Author's development

that exhibit different dynamics, identifying components with potential for further improvement, and determining appropriate management measures.

In assessing the efficiency of working capital utilisation, the volume of accounts receivable and its relationship with accounts payable represent important financial indicators. A substantial and rapidly increasing level of accounts receivable relative to accounts payable may indicate that a certain proportion of the enterprise's financial resources remains committed to customer accounts for an extended period. This may affect the speed of working capital turnover, influence liquidity, and reduce the availability of financial resources for meeting short-term obligations. Similarly, an increase in finished-goods inventories may indicate differences between production and sales dynamics, highlighting opportunities to further improve the efficiency of working capital management.

To strengthen financial management and ensure a differentiated approach to accounts receivable, a credit policy matrix is proposed based on the classification of customers according to payment discipline, duration of cooperation, and share of sales volume. This approach makes it possible to differentiate credit periods, discount terms, and monitoring frequency according to customer reliability, thereby supporting more effective accounts receivable management and working capital utilisation (Table 2).

Table 2
Credit Policy Matrix for Accounts Receivable Management²

Customer category	Criterion	Credit period	Discount	Monitoring frequency
Category A	Long-term cooperation, high payment discipline (>50% share)	45 days	2–3%	Quarterly
Category B	Medium-term cooperation, occasional delays (20–50% share)	30 days	1%	Monthly
Category C	New or high-risk customers (<20% share)	Advance payment or 15 days	–	Each transaction

The application of the proposed credit policy matrix can generate several important management outcomes. First, discounts offered to reliable Category A customers may encourage earlier payment and accelerate cash flows. Second, requiring advance payment from new customers or Category C customers requiring closer credit monitoring can contribute to maintaining an appropriate level of accounts receivable and strengthening financial stability. Third, differentiating the frequency of monitoring according to customer category enables financial management resources to be allocated more efficiently to priority areas.

When evaluating the effectiveness of credit policy, Days Sales Outstanding (DSO), which represents the average number of days required to collect accounts receivable, can be used as one of the key monitoring indicators. Monitoring this indicator over time makes it possible to assess accounts receivable turnover, observe changes in customer payment patterns, and adjust credit policy terms in a timely manner.

In assessing the efficiency of raw material inventory utilisation, the inventory turnover ratio and inventory holding period represent important indicators. These indicators can be determined using the following formulas:

$$\text{Inventory turnover ratio} = \frac{\text{Raw material costs}}{\text{Average raw material inventory}} \quad (2)$$

Inventory holding period:

$$\text{Inventory holding period} = \frac{365}{\text{Inventory turnover ratio}} \quad (3)$$

When inventory volumes increase at a faster rate than raw material consumption, the inventory turnover ratio may decrease, while the inventory holding period may increase. Consequently, a larger proportion of working capital may remain allocated to inventories for a longer period, affecting the overall speed of working capital turnover. Although maintaining an appropriate level of raw material inventory is essential for ensuring continuity of production, inventory levels that exceed operational requirements may increase storage costs and create opportunities for further improving working capital efficiency.

² Author's development

To maintain raw material inventories at an economically optimal level, the Economic Order Quantity (EOQ) model is proposed:

$$Q^* = \sqrt{(2 \times D \times S / H)} \quad (4)$$

where:

Q^* – optimal quantity of raw material per order (kg or tonnes);

D – annual demand for raw materials (units per year);

S – cost of placing and delivering a single order (UZS per order);

H – annual holding cost per unit of raw material (UZS per unit per year).

The application of the EOQ model makes it possible to determine an economically optimal balance between ordering and inventory holding costs. Accordingly, the model can support the maintenance of appropriate inventory levels, strengthen the continuity of raw material supply, optimise warehousing costs, and improve working capital turnover. In enterprises with relatively stable inventory turnover, the model can assist in maintaining an economically efficient inventory balance, whereas in enterprises experiencing rapid inventory growth, it can support the adjustment of stock levels in accordance with operational requirements.

CONCLUSION AND RECOMMENDATIONS

This study proposes an integrated approach to assessing and managing the efficient utilisation of production resources in textile enterprises through a set of interconnected methodological tools. Rather than assessing individual resource categories independently, the proposed approach considers the relationships among different production resources and establishes a direct link between assessment results and corresponding management decisions. From this perspective, the integrated assessment of human resource efficiency, differentiated management of accounts receivable, and optimisation of raw material inventories constitute three principal methodological directions.

The proposed Human Resource Efficiency Index (HREI) provides a comprehensive framework for integrating labour productivity, employee qualification levels, staff stability, and retraining rates into a single integrated indicator. The determination of weighting coefficients using the Delphi method enables the practical characteristics of the textile industry to be incorporated into the assessment and facilitates the identification of areas with potential for further improvement in human resource utilisation.

To enhance the efficiency of working capital utilisation, the proposed credit policy matrix differentiates customers according to payment discipline and the level of credit monitoring required. This approach supports the maintenance of accounts receivable at an economically appropriate level, contributes to cash-flow stability, and strengthens financial management. Regular monitoring of Days Sales Outstanding (DSO) provides an important analytical tool for evaluating the effectiveness of credit policy and adjusting its parameters in a timely manner.

In raw material resource management, the combined use of the inventory turnover ratio, inventory holding period, and Economic Order Quantity (EOQ) model provides a methodological basis for maintaining inventories at an economically optimal level, optimising storage costs, and improving the allocation of working capital. Consequently, this approach enables textile enterprises to maintain an appropriate balance between continuity of production and the efficient utilisation of financial resources.

Overall, the proposed methodological approaches provide a systematic basis for linking the results of production resource assessment with corresponding management decisions, identifying opportunities for improving resource efficiency, optimising production costs, and developing a resource-efficient management system consistent with the principles of the green economy. Their integrated application can contribute to more effective utilisation of human, material, and financial resources and support the sustainable development of textile enterprises.

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Proofreader: Xondamir Ismoilov
Layout and Designer: Hasan Maqsudov

2026. № 10

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