

# IMPROVING MODELS FOR EFFICIENT RESOURCE ALLOCATION ON THE BASIS OF DIGITALIZATION IN INDUSTRIAL ENTERPRISES OF UZBEKISTAN

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## Abstract

This article examines the issue of efficient resource allocation management in industrial enterprises of Uzbekistan under conditions of digital transformation. Based on the “Digital Uzbekistan – 2030” strategy and the regulatory and legal documents adopted on the digital economy, the importance of using digital technologies in enterprise activities is highlighted. In the research, resources are divided into labor, material, energy and financial groups, and their total volume is calculated according to the formula  $R = R_m + R_e + R_l + R_f$ . The efficiency of resource use is evaluated through the indicator  $E = Y / R$ . Using the example of two conditionally selected industrial enterprises, the indicators for the periods before and after digitalization are compared, and an increase in efficiency of up to 15–17 percent is observed. A simplified model based on linear programming is proposed for planning production volume under conditions of limited resources. The results of the study show the need to introduce digital monitoring of resources, to use ERP systems, and to expand data-driven management in industrial enterprises of Uzbekistan.

**Keywords:** Digital economy; industrial enterprise; resource allocation; resource efficiency; ERP system; linear programming; “Digital Uzbekistan – 2030”.

## Introduction

Under market economy conditions, the competitiveness of industrial enterprises primarily depends on how rationally and efficiently the available resources – labor, material, energy and financial resources – are used. When resources are allocated incorrectly, production costs increase, profit decreases, and the investment attractiveness of the enterprise declines. Therefore, managing resource allocation through scientifically grounded mechanisms is one of the most urgent tasks today.

In recent years, a number of measures have been taken in Uzbekistan to accelerate digital transformation, including the “Digital Uzbekistan – 2030” strategy and several decrees and resolutions aimed at developing the digital economy. These documents define the introduction of information systems, digital platforms and electronic management tools in economic sectors,



including industrial enterprises, as a priority task. Digital technologies make it possible to monitor resource flows online, accurately identify losses in energy and raw material consumption, and optimize production processes.

International studies widely cover the relationship between Industry 4.0, ERP systems and resource efficiency. It is noted that in enterprises that have implemented digital technologies, energy consumption and material losses decrease significantly. From this point of view, studying resource allocation in industrial enterprises of Uzbekistan specifically in connection with digitalization is of both scientific and practical importance.

The purpose of the study is to propose a system of indicators for assessing the efficiency of resource use on the example of industrial enterprises of Uzbekistan, to develop a simplified economic-mathematical model of resource allocation under digitalization, and to formulate practical recommendations.

## II. Literature Review

Although the concept of the digital economy is interpreted differently by various authors, they generally agree that digital data, networks and information and communication technologies are gradually becoming a key factor of production in economic processes. Research conducted in the context of Uzbekistan considers the digital economy as an important factor in economic growth, raising living standards and improving the business environment.

The issue of resource use efficiency in industrial production has been extensively studied within the framework of classical production theory and optimization approaches. In the traditional approach, the production outcome  $Y$  is expressed as:

$$Y = f(K, L, M, E)$$

where  $K$  – fixed capital,  $L$  – labor,  $M$  – material resources, and  $E$  – energy resources.

In recent years, studies within the framework of the Industry 4.0 concept have shown that technologies such as smart sensors, IoT, cyber-physical systems and digital twins enable real-time monitoring and optimization of energy and raw material consumption. Works devoted to energy efficiency, in particular, provide practical recommendations on reducing energy losses in manufacturing enterprises, optimizing loads and revising equipment operating modes.

Approaches to improving resource efficiency place special emphasis on the idea of “making material and energy consumption transparent,” that is, fully recording and analyzing all consumption. In this regard, it is recommended to use relative indicators and multi-factor models to assess resource use efficiency.

ERP (Enterprise Resource Planning) systems are playing an increasingly important role in enterprise management. The main advantages of production-oriented ERP systems include: inter-departmental integration, real-time control of warehouse stocks, monitoring of costs and profit in an integrated form, and automation of production planning. Analyses show that in enterprises where ERP systems are implemented, resource losses are reduced and the turnover of working capital accelerates.

This article is aimed at presenting these theoretical and practical approaches for the conditions of industrial enterprises in Uzbekistan using a simplified model and conditional empirical analysis.



### III. Methods

#### 3.1. Object of the Study and Approach

To demonstrate the methodological approach, two hypothetical industrial enterprises were selected as examples: Enterprise A (producer of construction materials) and Enterprise B (producer of plastic products). The data structurally correspond to real situations, but numerically are conditional and used to illustrate the method.

The following methods were used in the research:

- Comparative analysis – comparing indicators for the periods before and after digitalization;
- Relative indicators – calculation of the resource efficiency coefficient;
- Economic-mathematical modeling – a linear programming model;
- Comparative analysis with theoretical sources.

#### 3.2. Classification of Resources and Key Indicators

Resources are divided into the following groups:

- $R_m$  – material resources (raw materials, components, auxiliary materials);
- $R_e$  – energy resources (electricity, gas, fuel);
- $R_l$  – labor resources (wages, working time, social contributions);
- $R_f$  – financial resources (working capital, loan interest, etc.).

Total resource consumption is expressed by the following formula:

$$R = R_m + R_e + R_l + R_f$$

Product output:

$Y$  – volume of products manufactured during the year (in billion UZS).

Efficiency of resource use:

$$E = Y / R$$

where  $E$  is the indicator of resource use efficiency. The higher  $E$  is, the more efficiently the enterprise is considered to be using its resources.

#### 3.3. Assessing the Impact of Digitalization

For each enterprise, two periods are considered:

1st stage – the period before the introduction of digital monitoring and ERP systems;

2nd stage – the period after the phased introduction of digital systems.

For both periods, the indicators  $Y$  and  $R$  are calculated, and the resource efficiency coefficients  $E_1$  and  $E_2$  are compared. The percentage increase in efficiency is determined as follows:

$$\Delta E_{\text{percent}} = (E_2 - E_1) / E_1 * 100$$

#### 3.4. Model for Optimizing Resource Allocation

Let us assume that an enterprise produces  $N$  types of products ( $i = 1, 2, \dots, N$ ). For each product:

- $p_i$  – profit per unit of product  $i$  (UZS/unit);
- $Q_i$  – production volume of product  $i$  (units).

The objective is to maximize total profit. The objective function is:

$$\text{Max } Z = \sum (\text{from } i = 1 \text{ to } N) p_i * Q_i$$

The enterprise has  $M$  types of resources ( $j = 1, 2, \dots, M$ ):



- $a_{ij}$  – amount of resource  $j$  required to produce one unit of product  $i$ ;
- $B_j$  – total available stock of resource  $j$ .

Resource constraints:

$$\sum_{i=1}^N a_{ij} * Q_i \leq B_j \text{ (for each } j)$$

Non-negativity constraints:

$$Q_i \geq 0 \text{ (} i = 1, 2, \dots, N)$$

If the enterprise prioritizes resource saving, the objective function can be formulated as minimizing total resource consumption:

$$\text{Min } R_{\text{total}} = \sum_{j=1}^M \sum_{i=1}^N a_{ij} * Q_i$$

In this case, an additional production constraint is introduced:

$$\sum_{i=1}^N b_i * Q_i \geq Y_{\text{min}}$$

where  $b_i$  is the result indicator of product  $i$  (in value or volume terms), and  $Y_{\text{min}}$  is the planned minimum production volume.

## IV. Results

### 4.1. Results for Enterprise A

1st stage (before digitalization):

$$Y1 = 100 \text{ billion UZS}$$

$$R_{m1} = 55 \text{ billion UZS}$$

$$R_{e1} = 18 \text{ billion UZS}$$

$$R_{l1} = 15 \text{ billion UZS}$$

$$R_{f1} = 7 \text{ billion UZS}$$

Total resource consumption:

$$R1 = 55 + 18 + 15 + 7 = 95 \text{ billion UZS}$$

Resource efficiency:

$$E1 = Y1 / R1 = 100 / 95 \approx 1.05$$

2nd stage (after digitalization):

$$Y2 = 115 \text{ billion UZS}$$

$$R_{m2} = 56 \text{ billion UZS}$$

$$R_{e2} = 16 \text{ billion UZS}$$

$$R_{l2} = 15 \text{ billion UZS}$$

$$R_{f2} = 7 \text{ billion UZS}$$

Total resource consumption:

$$R2 = 56 + 16 + 15 + 7 = 94 \text{ billion UZS}$$

Resource efficiency:

$$E2 = Y2 / R2 = 115 / 94 \approx 1.22$$

Increase in efficiency (in percent):

$$\text{DeltaE}_{\text{percent}} = (E2 - E1) / E1 * 100$$

$$\approx (1.22 - 1.05) / 1.05 * 100 \approx 16.2 \%$$

These results show that, under conditions of introducing digital monitoring and management systems, Enterprise A has increased the efficiency of resource use by approximately 16 percent (based on conditional calculations).



## 4.2. Results for Enterprise B

1st stage:

$Y1' = 80$  billion UZS

$R1' = 78$  billion UZS

$E1' = 80 / 78 \approx 1.03$

2nd stage:

$Y2' = 92$  billion UZS

$R2' = 77$  billion UZS

$E2' = 92 / 77 \approx 1.19$

Increase in efficiency:

$\Delta E'_{\text{percent}} = (E2' - E1') / E1' * 100$

$\approx (1.19 - 1.03) / 1.03 * 100 \approx 15.5 \%$

Thus, at Enterprise B as well, the efficiency of resource use increases by more than 15 percent. From a practical point of view, these results can be explained by a reduction in raw material losses, a decrease in the share of defective products, and strict control over energy consumption.

## V. Discussion

Comparison of the research results with the literature review reveals several important points. First, an increase in resource efficiency of about 15–17 percent under conditions of introducing digital monitoring and accounting systems is largely consistent with the results presented in international studies on Industry 4.0 and energy efficiency. Real-time monitoring of energy and raw material consumption through smart sensors, IoT and cyber-physical systems reduces losses in production and optimizes resource use.

Second, the “Digital Uzbekistan – 2030” strategy and the decisions on the digital economy adopted in Uzbekistan provide institutional and organizational support for digital transformation in industrial enterprises. The proposed system of indicators (R, E) and the model for optimizing resource allocation make it possible to link these strategic goals with internal management mechanisms at the enterprise level.

Third, although the indicator  $E = Y / R$  is simple, it is very convenient for enterprises: it allows comparing resource efficiency across different periods, enterprises or sectors. At the same time, for deeper analysis, it is advisable to use this indicator together with additional metrics, such as energy consumption per unit of product, percentage of raw material losses, and the turnover rate of working capital.

Fourth, a limitation of the study is that the results are calculated on the basis of conditional data. For robust empirical conclusions, detailed statistical data on real industrial enterprises, regression analyses, and comparative studies by sectors and regions are needed.

## VI. Conclusion

The task of efficiently managing resource allocation in industrial enterprises of Uzbekistan is closely related to the requirements of the digital economy and Industry 4.0. By introducing digital monitoring, ERP systems and optimization models, it is possible to make resource flows more transparent, reduce losses and improve the financial performance of enterprises.



The indicators proposed in the article –

- total resource consumption:

$$R = R_m + R_e + R_l + R_f$$

- resource use efficiency:

$$E = Y / R$$

and the model of resource allocation optimization through linear programming can be regarded as practical tools for industrial enterprises. The conditional empirical results show that digitalization can increase resource efficiency by about 15–17 percent.

The approaches proposed in this article serve as a theoretical and methodological basis for the PhD research on “Improving mechanisms for effective management of resource allocation in industrial enterprises.” In the future, it is promising to deepen the model using real enterprise data, to conduct additional empirical research by sectors and regions, and to study other instruments of digital management (Big Data, artificial-intelligence-based forecasting, etc.).

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